MARINE SINGLE SIDEBAND

HULL MODEL 230

SSB RADIOTELEPHONE

INSTRUCTION MANUAL

- INSTALLATION
- OPERATION
- MAINTENANCE

AFTER SERIAL NO. 230038

HULL ELECTRONICS COMPANY

7563 CONVOY COURT, SAN DIEGO,
CALIFORNIA 92111 (619) 278-6140

TABLE OF CONTENTS

		PAGE
I.	GENERAL DESCRIPTION	
	DESCRIPTION	I-1
	EQUIPMENT FURNISHED	I-2
	SPECIFICATIONS	I-2
II.	OPERATION	
	GENERAL	II-1
	FRONT PANEL CONTROLS	II-1
	VOLUME - POWER ON/OFF	II-1
	MODE SWITCH	II-1
	KEYBOARD FUNCTIONS	II-2
	SELECTING A CHANNEL	II-2
	SCAN OPERATION	II-3
	EMERGENCY	II-3
	CLARIFIER	II-4
	POWER METER	II-4
	SQUELCH	II-4
	ERRORS	II-4
	OPERATING THE SSB TRANSMITTER	II-4
III.	INSTALLATION	
	GENERAL	III-1
	RADIOTELEPHONE	III-1
	POWER CABLES	III-1
	ANTENNA/GROUND SYSTEMS	III-1
	BASE STATION INSTALLATIONS	III-1
	SHIP INSTALLATIONS	III-2
	NOISE SUPPRESSION	III-2
	SQUELCH ADJUSTMENT	III-3
	OPERATIONAL CHECK	III-3
	AUXILIARY EQUIPMENT	III-3
	OPTIONAL MODULES	III-4
IV.	THEORY OF OPERATION	
	GENERAL	IV-1
	BLOCK DIAGRAM	IV-1
	RECEIVE FUNCTION	IV-1
	TRANSMIT FUNCTION	IV-1
	FREQUENCY SYNTHESIZER	IV-2
	SCHEMATIC DIAGRAM	IV-3
	RECEIVE FUNCTION	IV-3
	RECEIVE INPUT	IV-3
	AGC	IV-3
	MIXERS	IV-3
	AUDIO AMPLIFIERS	IV-4
	SQUELCH	IV-4
	TRANSMIT FUNCTION	IV-4
	MICROPHONE AMPLIFIER	IV-4

MIXERS AND FILTERS IV-4
TRANSMIT IF AMPLIFIER IV-5
TRANSMIT POWER AMPLIFIER IV-5
T/R DELAY IV-5
CARRIER INSERTION IV-5
TIMING CIRCUITS IV-5
CARRIER VCO IV-6
HF VCO IV-6
50 MHZ VCO IV-7
LOGIC CIRCUITRY IV-7
DIGITAL POWER METER IV-7
SCAN IV-8
DISPLAY IV-8
FILTER BOARD IV-8
HARMONIC FILTERS IV-8
POWER DETECTOR IV-8
VSWR DETECTOR IV-8
SWR AMPLIFIER IV-8
COUPLER KEYING IV-9
OPTIONAL EQUIPMENT IV-9
EMERGENCY TONE GENERATOR IV-9
CW MODULE IV-9

V. MAINTENANCE AND REPAIR

GENERAL V-1
EQUIPMENT NEEDED V-1
FREQUENCY RESET V-1
ADJUSTMENTS V-1
SQUELCH V-1
BAL (EXCITER BOARD) V-2
CARRIER INSERT (EXCITER BOARD) V-2
CARRIER VCO (EXCITER BOARD) V-2
TUNE (FILTER BOARD) V-2
ALC (FILTER BOARD) V-2
SWR (FILTER BOARD) V-2
MTR (FILTER BOARD) V-3
MTR (SYNTHESIZER BOARD) V-3
RECEIVER ALIGNMENT V-3
TRANSMITTER ALIGNMENT V-3
EMERGENCY TONE GENERATOR V-3
LIVE OPERATIONAL TEST V-3
TONE ADJUSTMENT V-3
LITHIUM BATTERY REPLACEMENT V-4
SCAN CONTROL V-4

SECTION I

GENERAL DESCRIPTION

DESCRIPTION

The Hull Model 230 Single-sideband radiotelephone is intended to provide communications between ships, and from ships to private or public shore stations. The unit also supplies the needs for point-to-point communications between land stations. Frequency coverage is 1.6 - 29.9 MHz in 100-Hz steps. Channel selection is by a front-panel keyboard. Up to 100 channels may be installed at the factory in a permanent memory. Additionally, up to 200 channels may be stored in memory by the user. Any of the Ship-to-Shore HF channels (ITU) may be selected by the keyboard.

Up to ten channels may be placed in user memory and scanned sequentially. The scanning can be stopped and restarted either using the keyboard or remotely.

Model 230 is capable of CW, LSB, USB, AME and FSK modes of operation. Mode selection is by a front-panel selector knob. A Digital Transmitter Power Output Indicator is provided for monitoring transmitter performance.

Nominal power output is 150 watts PEP when transmitting A3J. Carrier power when transmitting A3H is 37 watts. The unit is capable of transmitting 150 watts continuous power in the CW and FSK modes when provided with an accessory cooling fan and heavy duty power supply. Without the fan and external power supply, power in these modes is limited to 50 watts.

When properly installed and adjusted, Model 230 meets or exceeds all applicable FCC requirements.

Hull Model 230 SSB radiotelephone is fully transistorized to reduce power drain and to insure long trouble-free service. The equipment is a complete single-package unit intended for shelf, ceiling, or bulkhead mounting. The set interior is accessible for service by removing the outer cover. Those portions of the unit most likely to require service are contained on printed-circuit cards equipped with plug-in connectors for easy replacement.

Model 230 may be supplied for operation from either a nominal 13.8 Volt DC, or 120/240 Volt AC power source. Accessory power supplies are available for high-power CW or FSK service.

Model 230 is FCC Type Accepted for use under parts 80, 87, and 90 of the Commission's Rules and Regulations. The FCC ID is CVN7WK230.

EQUIPMENT FURNISHED

1. Hull Model 230 Radiotelephone with attached microphone
2. Instruction manual with circuit diagrams
3. Channel Identification chart

SPECIFICATIONS

Number of channels -	150,000 by direct keyboard entry All ITU channels by channel number 100 by permanent memory 200 by user memory 10 for Scan operation
Frequency range -	1.6 - 29.9 MHz in 100-Hz steps
Operating modes -	A3J, A3H. A1, F1 Optional
Frequency stability -	+/- 15 Hz
Frequency control -	Frequency synthesizer with temperature stabilized crystal time base
Spurious emissions -	Exceeds FCC requirements under Parts 80, 87, and 90.
Power output -	150 Watts PEP (A3J) 50 Watts (A1 & F1) 150 Watts (A1 & F1 with fan and external power supply) 37 Watts (A3H)
Output impedance -	50 Ohms coaxial cable output
Receiver sensitivity -	Less than 1 uv for 10db SINAD (SSB) Less than 3 uv for 10db SINAD (AM)
Receiver selectivity -	6db down: 2.4 KHz (SSB) 6.5 KHz (AM 60db down: 4.8 KHz (SSB) 20 KHz (AM)
Spurious rejection -	Better than 80db down
Receiver audio output -	5 watts at 4 ohms 10% THD
Power requirements -	Receive: 13.8 VDC at 0.5 A Transmit speech: 13.8 VDC at 18 A
Mechanical -	Dimensions: 4.6"H x 12.3"kW x 15.0"D Weight: 14 lb

SECTION II

OPERATION

CAUTION

DO NOT ATTEMPT TO TRANSMIT UNTIL THE RADIO HAS BEEN TURNED ON FOR AT LEAST 5 MINUTES.

The crystal controlling the transmitting frequency is equipped with a precision oven that requires 5 minutes to stabilize in temperature. Transmitting before the 5 minute warm-up period has elapsed can cause a violation of FCC regulations. (MAYDAY conditions are excepted)

GENERAL

The Model 230 SSB Radiotelephone will provide communications between ships and from ships to private or public shore stations. The set will also provide communications between point-to-point land stations. The method of operation is simple and straightforward but the following information covering front-panel controls should be carefully studied to insure optimum performance.

No attempt should be made to operate the unit until it has been properly installed and tested by a licensed technician. The operator of this unit may require a valid operator's license. He may permit unlicensed persons to speak over the transmitter under certain conditions. Refer to applicable FCC Rules and Regulations or ask your dealer to assist you regarding operator requirements.

FRONT PANEL CONTROLS

VOLUME - POWER ON/OFF

This control combines the power on/off switch and the receiver volume control. With the control fully counter-clockwise, all power to the set is removed. Rotating the control clockwise past the click turns the equipment on and noise will be heard from the speaker. Adjust the control for the approximate loudness desired.

MODE SWITCH

The MODE switch selects the desired operating mode. For normal SSB operation the switch should be set to USB (Upper Sideband). In some parts of the world, emergency communications on the international distress frequency (2182.0 KHz) requires the use of AME (Carrier plus sideband). Set the MODE switch to AME when this type of communication is needed.

LSB, CW, and FSK are optional modes and require accessory items that are normally installed at the factory. LSB (Lower Sideband) is occasionally required in special applications and requires a special filter. CW (Continuous Wave) is used when communicating by telegraph using Morse code. The CW function requires a CW module, available at the factory, and an external telegraph key. FSK (Frequency Shift Keying) is used with external teletype equipment and, again, requires a special filter available from the factory. Connection to the external equipment is made through a rear-panel accessory plug.

KEYBOARD FUNCTIONS

In addition to selecting the desired frequency channel, the keyboard controls the Squelch function and Channel Scanning. Any channel frequencies to be placed in memory for future use are made through the keyboard. Finally, if the unit is equipped for two-tone Emergency signalling, selection of this function is made through the keyboard.

SELECTING A CHANNEL

The desired channel may be selected directly by pressing the digits of the frequency (or frequencies in the case of half-duplex operation) on the keyboard. For example, to select 2738.0 KHz simplex, press in sequence 2, 7, 3, 8 and 0 on the keyboard. Finally, press the T/R key. When finished with the channel, press the CLR key. The set is now ready for another selection.

To select a half-duplex channel, press keys for the desired receive frequency followed by the R key. Then press in sequence the desired transmit frequency followed by the T/R key. Note that the display reads the receive frequency when receiving and, by pressing the microphone button, the transmitting frequency. Again, when finished with the channel, the CLR key clears the unit for another selection.

Any Ship-to-Shore public service (ITU) channel may be selected by first pressing the CH key and then, in sequence, the channel number of the desired ITU station. A handy list of all ITU channels is packed with the equipment and should be retained for reference.

Channel numbers in the range 100-199 are reserved for factory programming. A number of frequencies have been stored in this block by the factory and a list is supplied with the set. After determining the desired channel number, press the CH key and in sequence the desired channel number. Press the CLR key when you have finished with the channel.

Channel numbers in the range 201-399 (except 220 thru 229) are reserved for storage by the user. To store a simplex channel into user memory, proceed as follows:

1. Press CH and the digits of the desired channel number. If the channel is vacant, six dashes will appear on the display. Press the CLR key. A single "0" will appear.

2. Press in sequence the digits of the desired frequency. Finally, press the STO key. The channel frequency is now stored and can be reacquired at any time by pressing CH and the channel number. Make certain you record the stored channel number and frequency for future reference.

To store a half-duplex channel into user memory:

1. Press CH and the digits of the desired channel number. Six dashes will appear on the display. Press the CLR key. A single "0" will appear.

2. Press in sequence the digits of the desired receive frequency. Next, press the R key. Now, press the digits of the transmit frequency. Finally, press the STO key.

To erase a frequency from user memory:

1. Press CH and the channel number to be erased. Next, press the CLR key. Finally, press the STO key.

SCAN OPERATION

Channel numbers 501 through 510 are reserved for frequencies to be scanned. First enter the desired frequencies (up to 10) using the procedure given above. The channels may be either simplex or half duplex. After all channels are entered, press CH and the channel number for any one of the entered frequencies. To begin scanning, press the "7" key. Each channel will be "looked at" for a period of one second before moving to the next channel. The "look" period can be changed to three seconds by pressing the "3" key. Similarily, a period of six or nine seconds can be set by pressing the "6" or "9" key respectively. To stop on any channel being looked at, press the "8" key. Pressing the "7" key will re-start the scan. Scanning can also be stopped by the Squelch system by activating circuitry contained in the set. See Section V of this manual for details. Finally, scanning can be stopped remotely. See Section III of this manual for details.

EMERGENCY

If the set has been equipped with the optional EMER module, the two-tone EMERGENCY tone is activated by first pressing the CLR key and then simultaneously pressing the "4" and "5" keys for a period of 1 second. The tone signal will continue for 35 seconds

before shutting off. The tones can be terminated prior to 35 seconds by pressing the CLR key.

CLARIFIER

If the received signal sounds garbled and either high or low in pitch, press the "1" or "2" key as necessary to provide a natural sound. Note that the frequency reading on the display is changed by 100 Hz each time the "1" or "2" key is pressed. The transmitted frequency is not affected.

POWER METER

The Model 230 is equipped to give a digital indication of transmitted power. After the set is properly installed and operating, press the MTR key, press the microphone and either whistle or speak an extended "AHHHH" into the microphone. The display will indicate the peak power being transmitted. Remember that many factors can affect actual transmitter power; battery voltage, length of wiring from the battery to the set, and loudness of the speaker's voice are a few. The reading should be used for reference only and as an indication of normal performance.

SQUELCH

After a channel has been selected, extraneous noise between transmissions from the station being received can be blanked out by pressing the "0" key. Note that a dot at the upper left corner of the display lights when the squelch function is being used.

ERRORS

Occasionally the display will indicate "Error" when the keyboard is being actuated. The "Error" indication usually occurs when an invalid channel has been selected or when the selected frequency is either above or below the frequency range of the set. To correct, press the CLR key and try again.

OPERATING THE SSB TRANSMITTER

Operating the single-sideband (SSB) radiotelephone is quite similar to other types of radio equipment. After the desired channel is selected, press the microphone button and begin speaking. Speak in a normal tone of voice with the microphone held close to the mouth. DO NOT SHOUT. The transmitter incorporates an AUTOMATIC LEVEL CONTROL that adjusts the unit for variations in voice level. Shouting is not necessary; it does not increase transmitter output and only garbles the signal so that readability is reduced.

Remember that you cannot acknowledge a transmission from the other station by merely "blipping" the mic button; the receiving station will hear nothing until you actually speak.

SECTION III

INSTALLATION

GENERAL

Installation of the Model 230 consists of locating and mounting the radiotelephone, installing cables to the power source, and erecting a suitable antenna/ground system.

RADIOTELEPHONE

Select a convenient operating location for the set. If the mounting cradle is used it is reversible so that the set may be mounted on an existing shelf, to a bulkhead, or to an overhead surface. A small bracket at the rear of the mounting cradle is intended to engage a slot on the large heatsink at the rear of the radiotelephone. The bracket is supplied for shelf mounting; it is necessary to reverse the bracket and change the location of the engaging pin when the set is overhead or bulkhead mounted.

POWER CABLES

If the Model 230 is operated from a 13.8 Volt DC power source, peak current may be as high as 25 amps. Power cables should be at least 10-gauge wire for cable runs up to 12 feet; for longer runs use at least 8-gauge wire. When connecting the set, proper polarity must be observed. A protective diode in the set will blow a rear-panel circuit breaker if the power cables are improperly connected.

If the unit is operated from a 120/240 Volt power source, a normal power cable is adequate provided the run is reasonably short.

ANTENNA/GROUND SYSTEMS

The Model 230 requires an antenna system of essentially 50 ohms resistive if full transmitter power is to be produced. If the VSWR rises much above 2 to 1, circuits in the radiotelephone act to reduce power output to prevent damage to the unit. For this reason, good performance can be obtained only if a properly matched antenna system is provided.

BASE STATION INSTALLATIONS

The most convenient antenna system for base-station use is the Broadband Folded Dipole antenna type offered by Barker & Williamson, Bristol, Pa. Three models are available:

MODEL	FREQUENCY RANGE	GROUND SPACE NEEDED
AC 3.5-30	3.5 - 30 MHz	85 feet
AC 2-22	2.0 - 22 MHz	185 feet
AC 1.8-30	1.8 - 30 MHz	110 feet

The antennas listed all provide adequate matching to the Model 230 transmitter without the use of Couplers or ground systems and offer good radiation performance.

If space is restricted, a vertical whip antenna yields reasonably good performance provided a suitable ground sytem and Antenna Coupler are used. Hull offers Model H-403CU Automatic Antenna Coupler for use with the Model 230 SSB. This unit matches any antenna 8 feet or longer in length throughout the frequency range 1.6 - 30 MHz. Efficient radiation will be obtained only if a good ground system is provided. This may consist of a series of wire radials buried in the ground under the antenna, a metal rooftop, or other metal mass.

SHIP INSTALLATIONS

Most ship installations, due to restricted space, will consist of vertical whip or fairly short wire antennas. An Automatic Antenna Coupler such as the Hull Model H-403CU is required to match the antenna to the SSB. Grounding, in the case of metal vessels, consists of a short heavy connection from the ground terminal of the coupler to the metal hull. Grounding on wood or glass vessels can consist of wire mesh or copper sheeting installed near the waterline of the vessel. In addition, large metal masses such as fuel tanks, copper hydraulic lines, engine blocks, etc., should be bonded together and connected in parallel with the sheeting. A short direct connection to the coupler ground terminal is very important.

If some frequencies do not provide good communications and the antenna/ground system is suspected, a wire counterpoise, 1/4 wavelength long at the desired frquency, may be installed near deck level with one end connected to the ground terminal of the coupler. Counterpoise length in feet can be determined by dividing 234 by the frequency in MHz.

NOISE SUPPRESSION

The Model 230 incorporates a highly sensitive receiver that responds to interfering noise. Optimum performance can be obtained only if the electrical system on the vessel is treated for suppression of noise. The techniques to be used are identical to those for any marine installation and include bypassing and filtering of alternators and the use of radio suppressors or shielding of ignition systems.

After the installation has been noise suppressed, the set should be operated with all electrical equipment running. Listen for signs of receiver blocking in both SSB and AM modes. If blocking

occurs, optimum receiver performance cannot be expected. Locate the equipment causing the interference and treat as necessary to eliminate the problem.

SQUELCH ADJUSTMENT

After the antenna system has been found to be operating correctly on all desired channels, test to see that the squelch operates properly. If noise bursts alone cause the squelch to break, adjust the SQUELCH control slightly clockwise. The control is located near the forward edge of the Exciter circuit board and is available by removing the unit cover. After each adjustment of the control, wait several seconds before deciding if further adjustment is needed. If weak signals do not break the squelch turn the control slightly counter-clockwise, again waiting a few seconds before adjusting further.

OPERATIONAL CHECK

After installation has been completed, a thorough operational check should be made. Begin by loosely coupling a frequency counter to the antenna lead and, with the set adjusted to transmit AME, measure the transmitting frequency on several selected channels. Any error must be corrected. See FREQUENCY ADJUSTMENT paragraphs in Section V of this manual.

If the Model H-403CU Automatic Antenna Coupler is a part of the system, see that all of the channels to be used tune correctly. With a VSWR meter inserted in the coaxial line connecting the set to the Coupler, make certain that each channel tunes to a VSWR of less than 1.5 to 1.

If the Emergency Tone Generator is installed, a live test of its function can be made by pressing the "4" and "5" keys simultaneously for one second. The system will select 2142.0 KHz and transmit a two-tone signal for 35 seconds. Never test on 2182.0 KHz into a live antenna since this would broadcast an actual emergency signal.

Finally, make air checks on as many channels as possible.

AUXILIARY EQUIPMENT

A rear-panel connector provides access to various circuits within the radiotelephone to enable operation with RF Amplifiers, ARQ Terminals and Selcal units. The functions of the individual pins are given in the Interconnect Schematic diagram at the rear of this manual. Connections include:

Harmonic Filter selection (6 pins)

PIN NO.	FILTER
6	1.6 - 2.8 MHz
7	2.8 - 4.5 MHz
8	4.5 - 7.0 MHz
9	7.0 - 11 MHz
10	11 - 19 MHz
11	19 - 30 MHz

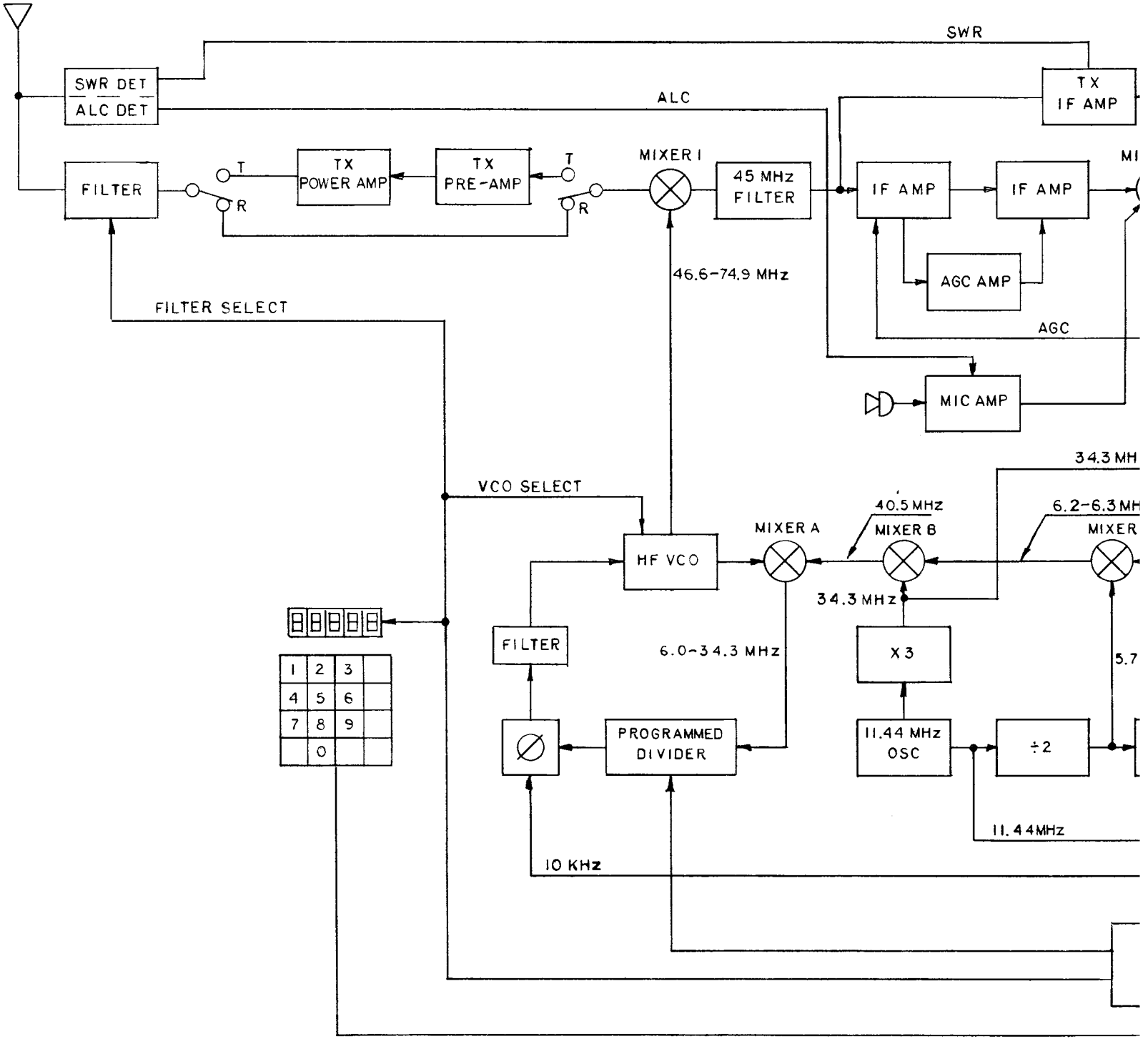
Pin 2 - +12 VDC, switched on by VOL control
Pin 3 - 600 ohm AF out
Pin 4 - " " " " (squelched)
Pin 5 - Push-to-talk
Pin 12 - CW Key (used woth CW Module)
Pin 13 - XMT ALC (+5 volts peak required)
Pin 14 - Microphone input
Pin 15 - Scan. Ground this lead to interrupt channel scanning.

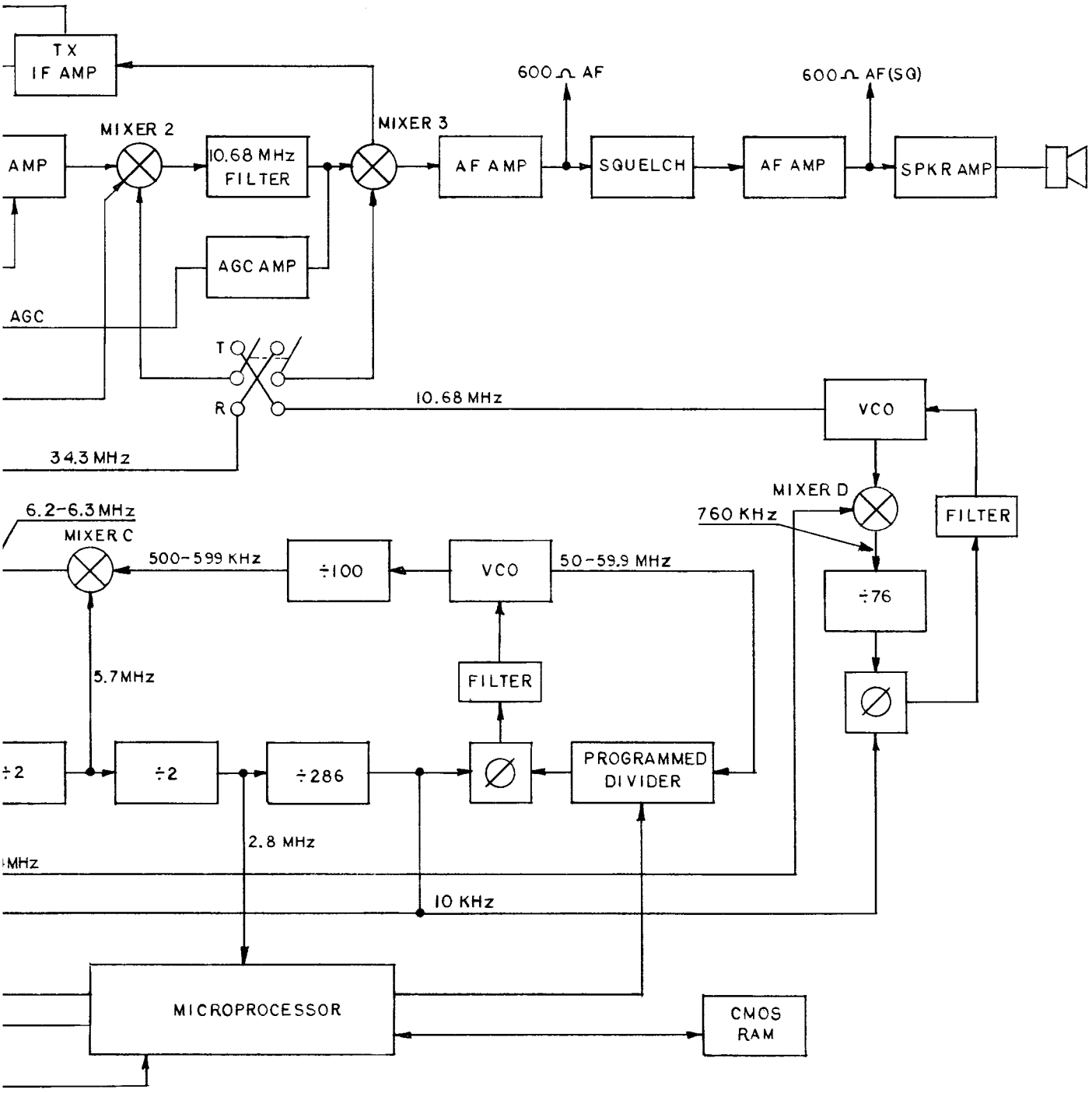
OPTIONAL MODULES

A CW Adaptor and a two-tone emergency tone generator are available as optional accessories. These items may be field installed or ordered pre-installed from the factory. A narrow bandpass IF filter is available (factory installed) for CW operation. Properly installed, the filter is automatically selected when the front-panel MODE selector switch is in CW position.

A special narrow-passband IF filter for FSK (teleprinter) operation is available as an option to improve FSK operation. Similarly, an IF filter for LSB operation can be obtained as an option. Normally only one of the above filters (CW, FSK, LSB) can be installed in the Model 230. If more than one filter is needed, contact the factory.

Note that the front-panel MODE selector must be re-wired to accomodate any auxiliary IF filters. The MODE switch wiring is shown on the Interconnect diagram at the rear of this manual. To select the installed auxiliary IF filter, the "MODE" lead must be at ground potential.


SWR
SWR DET
ALC DET
ALC
TX
IF AMP
FILTER
T
R
TX
POWER AMP
TX
PRE-AMP
T
R
MIXER 1
45 MHz
FILTER
IF AMP
IF AMP
MI
AGC AMP
AGC
46.6-74.9 MHz
FILTER SELECT
MIC AMP
34.3 MH
VCO SELECT
40.5 MHz
MIXER B
MIXER A
6.2-6.3 MH
MIXER
HF VCO
34.3 MHz
FILTER
6.0-34.3 MHz
X3
5.7
1 2 3
4 5 6
7 8 9
0
PROGRAMMED
DIVIDER
11.44 MHz
OSC
÷2
11.44MHz
10 KHz



MODEL 230
BLOCK DIAGRAM

SECTION IV

THEORY OF OPERATION

GENERAL

Section IV provides a technical description of the Model 230 SSB Radiotelephone. A simplified block-diagram explanation of the receive and transmit functions is given as well as the operation of the frequency synthesizer. Following the block-diagram explanation, detailed descriptions of the various circuits are given.

BLOCK DIAGRAM

RECEIVE FUNCTION

A signal appearing at the antenna is passed through a selected harmonic filter. The signal is then applied to one port of Mixer 1. A second mixer port receives an injection from the frequency synthesizer that is 45 MHz higher in frequency than the incoming signal. The difference frequency appears at the third mixer port and is passed through a 45-MHz bandpass filter to the input of a two-stage IF amplifier. The amplified signal is fed to the input of Mixer 2. A 34-MHz injection is applied to a second input of this mixer. The mixer output at 10.68 MHz, is filtered and fed to the input of Mixer 3. Mixer 3 also receives a 10.68-MHz injection to produce an audio signal in the mixer output output.

The audio signal is amplified, passed through a voice-actuated squelch, and finally amplified to speaker level.

The 10.68-MHz signal at the output of the 10.68-MHz filter is also connected to an AGC amplifier. Output from this amplifier is rectified and serves to control the gain of the IF amplifier stages. Rectified output from the AGC amplifier also delivers audio when the receiver is operating in the AM mode.

TRANSMIT FUNCTION

When the microphone button is pressed, audio from the microphone is passed through a gain-variable amplifier and applied to an input port of Mixer 2. In the transmit mode, the second input to this mixer is at 10.68 MHz. Mixer output is a double-sideband suppressed-carrier signal centered at 10.68 MHz. The 10.68-MHz filter removes the unwanted sideband and further suppresses the carrier. The SSB signal is then combined in Mixer 3 with an injection at 34 MHz to produce a 45-MHz Transmit IF.

The Transmit IF is amplified and coupled to the 45-MHz filter. Filtered output is combined in Mixer 1 with an injection from the frequency synthesizer that is 45 MHz higher in frequency than the desired output frequency.

Output from Mixer 1 is amplified to the desired transmitter output level and passed through a selected harmonic filter to the antenna.

A sample of the transmitter output signal is rectified and functions to control the gain of the microphone amplifier thus limiting power output to the rated level. The VSWR existing on the transmitter output line is also detected. An excessive VSWR produces a DC output which is applied to the Transmit IF Amplifier to reduce amplifier gain. The Transmit Power Amplifier is thus protected from damage in the event of improper load conditions.

FREQUENCY SYNTHESIZER

The synthesizer portion of Model 230 produces three outputs; a HF injection 45 MHz higher in frequency than the desired signal, an injection at 34.32 MHz, and an injection at 10.68 MHz. The three outputs have the same accuracy as a precision crystal time base operating at 11,440.0 KHz.

The HF injection is generated by the HF Voltage Controlled Oscillator (HF VCO). Output from this stage is also applied to an input of Mixer A. Here the signal is combined with a second input in the vicinity of 40.5 MHz to produce a mixer output in the range 6.0 - 34.3. This output is then applied to a programmed divider chain which is instructed by a microprocessor to produce a 10-KHz divider output. This output is then combined in a phase discriminator with a 10-KHz reference derived from the time base. Discriminator output is filtered and applied to the HF VCO to accurately lock it to the desired frequency.

The 40.5-MHz input to Mixer A is obtained from Mixer B which receives a 34.3-MHz input derived by tripling the time base frequency. A second input to Mixer B in the range 6.2 - 6.3 MHz is obtained from the output of Mixer C. This mixer combines an input at 5.7 MHz (one-half time base Frequency) with a second input in the range 500 - 599 KHz. This second input is generated by a VCO operating in the range 50 - 59.9 MHz. The exact frequency of the 50-MHz VCO is again controlled by the microprocessor which instructs a programmed divider chain similar to the divider associated with the HF VCO. Again, divider output is combined with the 10-KHz reference in a phase discriminator which, in turn, controls the 50-MHz VCO with the same accuracy as the time base.

The 10.68-MHz injection is generated by a VCO which also supplies one input to Mixer D. A second input to Mixer D is the time base frequency. The difference between the two inputs, 760 KHz, is divided to produce a 10-KHz output. This output is compared with the 10-KHz reference in a phase discriminator, output from which controls the 10.68-MHz VCO with the same accuracy as the time base.

The microprocessor controls the two programmed dividers referred to above as well as the front-panel display. Instructions to the processor are received either directly from the front-panel keyboard or from a CMOS RAM equipped by a lithium keep-alive battery. The RAM enables storage of channel information at the user level. A 2.86-MHz clock, obtained from the system time base, controls timing within the processor.

SCHEMATIC DIAGRAM

NOTE: In the schematic diagrams, reference is made to a +R, +T, +13T and +SSB lines. It is understood that a +R line, for example, is supplied with +8 Volts DC only when the set is in the receive mode. The line is clamped to ground when in the opposite mode.

RECEIVE FUNCTION

RECEIVE INPUT

Referring to the Exciter Board schematic diagram at the rear of this manual, an incoming signal appearing at pin 4 of J101 is fed through K101 and Low-pass Filter L102 and L103 to Bilateral Mixer Z101. The signal is combined with a LO injection from pin 6 of J101 to produce a mixer output of 45 MHz. This output is filtered by Z102 and applied to gate 1 of IF Amplifier Q104. Here, the signal is amplified and passed to U102 for further amplification.

AGC

Overall gain of Q104 and U102 is controlled by a negative-going DC voltage applied to both gates of Q104. As the AGC voltage swings negatively, current through Q104 is reduced and the voltage across source resister R213 drops. Since the voltage across R213 controls conduction through Q105, the DC potential on pin 5 of U102 rises thus reducing the gain of this stage. The effect is to hold output from the two-stage amplifier substantially constant with widely varying input levels.

MIXERS

Output from U102 is applied to an input of Mixer U104. Here the signal is combined with a 34320-KHz injection through Diodes CR117-120. The 10.68-MHz output from U104 is passed through narrow-band Filter Z104 and fed to one input of Mixer U105. The signal is then combined with a 10.68-MHz injection delivered through Diode Quad CR117-120 to produce an audio output.

Output from filter Z104 is also applied to the input of AGC amplifier U106 and output from this stage is rectified by CR115 and CR122 to produce a negative-going AGC voltage and AM audio.

AUDIO AMPLIFIERS

Audio from either U105 or U106 is selected by U108A, B, & D and applied to Amplifier U107A. This stage produces a 600-ohm output and is also passed through the remaining section of U108 which functions as a squelch switch. The audio is then further amplified by U107B and passed through the front-panel volume control to Speaker Amplifier U117 which produces a speaker-level output.

SQUELCH

Quad-gates U109 and U110 are configured to function as a voice-actuated squelch. Incoming audio is amplified by U109C and squared by U109D. The squared output is applied to one-shot multivibrator U109A & B which produces a constant-width pulse output with each cycle of the incoming audio. These pulses are integrated by CR109 and any change in the DC level is passed through R165 and C157 to U110C. Here the level change is amplified and a measured amount is applied through Squelch Control R183 to U110D. Any drop in the level change causes CR110 to conduct which, in turn, causes one-shot Multivibrator U110A & B to fire.

If the level change rises, the one-shot times out. If the level change continues to drop, the one-shot remains in the "fired" state indefinitely. With the one-shot fired, U105C conducts and audio passes through. When the one-shot is off, audio is blocked and the receiver is squelched off.

The time constants of amplifier U110C and Input Network C157 and R183 favor frequencies in the 10-Hz region, the syllabic rate of a normal human voice. Thus, the system responds largely to human speech and noise pulses have little or no effect.

TRANSMIT FUNCTION

MICROPHONE AMPLIFIER

When the microphone button is pressed, audio at the microphone is passed through gain-variable amplifier U103. The gain of this stage can be reduced by a positive-going DC voltage applied to pin 2. The DC voltage is produced by the ALC detector and appears when the transmitted output reaches 150 Watts PEP.

MIXERS AND FILTERS

Output from U102 is fed to an input of Mixer U104 where it is combined with a 10.68-MHz injection arriving through diode quad CR117-120. The 10.68-MHz carrier is partially suppressed by U104 and output from this stage is a double-sideband signal centered at 10.68 MHz. Filter Z104 eliminates the unwanted sideband and supplies additional carrier suppression.

Selection of several optional filters can be made by applying a

DC voltage to pin 11 of J101. Filters are available for optimum performance in the FSK and CW modes as well as for lower-sideband operation (LSB). The correct filter is automatically selected when the front-panel Mode selector switch is operated.

TRANSMIT IF AMPLIFIER

Output from Filter Z104 is applied to an input of U105 where it is combined with a 34.3-MHz injection to produce a 45-MHz mixer output. This output is amplified by U101. The gain of U101 can be reduced as needed by a positive-going DC voltage on pin 5. Two controls are applied; output from a VSWR detector appearing at pin 14 of J101, and a LOCK detector in the synthesizer section.

TRANSMIT POWER AMPLIFIER

Output from U101 is passed through 45-MHz Filter Z102 and applied to one port of Mixer Z101. Here the signal is combined with the HF VCO injection to produce a SSB signal at the desired operating frequency. Output from Z101 leads through K1 Q101-Q103, a three-stage preamplifier. Amplified output leaves the exciter board through J103 to be fed to the RF power amplifier.

T/R DELAY

When the Transmit Power amplifier is being keyed on and off rapidly such as for CW or ARQ operation, It is important that drive to the amplifier be removed before the +13T relay, K314 on the Filter board, is de-energized. CR301 and C3341 delay the release of K314 when the terminal labelled MODE SWITCH is grounded. The delay action is enabled when the MODE switch is set to either CW or FSK.

CARRIER INSERTION

It is necessary to insert a measured amount of carrier into the transmitted signal when operating in the AME mode. A small amount of carrier is also needed when the set is operated with an Automatic Antenna Coupler. Control of inserted carrier is provided by Q107 and Q108. A sample of the 10.68 MHz injection is applied through Carrier Control R164 and CR116 to the input of Q107. Output on the emitter of this stage is coupled to an input of U105. Q108 clamps the input of Q107 whenever a positive DC voltage is applied from pin 30 of J102. This voltage is always present except when AME has been selected or when the Antenna Coupler is being tuned. Control R164 is set for 37 watts carrier output at 2182 KHz when AME is selected. A circuit on the Filter board automatically adjusts carrier output to approximately 10 watts at any frequency when the Coupler is tuning.

TIMING CIRCUITS

The master 11440.0-KHz time base consists of Y101 and Oscillator Q116. Exact frequency is adjusted by C181. Two coupled tuned

circuits in the collector of Q116 select the third harmonic of the oscillator to provide a 34.3-MHz injection to mixers 2 and 3 and, through Q117, to a mixer on the Synthesizer board.

The time-base oscillator output is also passed through Q115 and squaring amplifier Q114 to Divider U116. This stage delivers outputs at 5720 KHz (pin 36, J102) and at 2860 KHz (pin 40, J102). An output from U116 at 1430 KHz is fed to Divider U115 and U114 which are arranged to further divide the time-base frequency by a factor of 143 to produce a reference output at exactly 10 KHz. This reference is applied to the three phase discriminators in the system.

CARRIER VCO

Oscilllator Q113 operates at 10.68 MHz. A sample of output from this stage is applied to the base of Mixer Q112 which also receives an input from the master time base. The difference frequency of the two inputs (760 KHz) appears at the collector of Q112 and is coupled to Squaring Amplifier Q111. Output from this stage drives Divider U112 and U111 which is arranged to divide by a factor of 76. Output from the divider is compared with the 10-KHz reference in U113 and DC output from this stage is filtered and applied back to the VCO to accurately lock this stage to the desired frequency.

FREQUENCY SYNTHESIZER

HF VCO

Referring to the Synthesizer schematic diagram, Q2, Q4 and Q6 are connected as voltage-controlled oscillators (VCO) with RF outputs combined. Any of the three VCO's can be selected by applying a DC high voltage to the base of Q3, Q5, or Q7. Each oscillator covers a discrete frequency range as follows:

Q2 - 46.6-55.9 MHz
Q4 - 56.0-63.9
Q6 - 64.0-74.9

Note that the lowest frequency VCO is equipped with a padding capacitor (C2) which, when switched into the circuit by Q1, extends the VCO tuning range. This addition is not required on the other oscillators. The appropriate oscillator is activated automatically by the microprocessor when a channel is selected.

VCO output is amplified by Q8, Q9 and Q10 with one amplified output leading to the Exciter board and a second output coupled to Mixer U22. Mixer U22 also receives an input in the vicinity of 40.5 Mhz and the two inputs are combined to produce an output in the range 6.0 to 34.3 MHz which is amplified to logic level by Q24 and Q25. This output is then applied to a programmed divider consisting of U23 through U30 which is instructed by the processor to provide a 10-KHz output. This output is combined with the 10KHz reference in phase discriminator U10 to produce a DC output which is filtered and applied to the HF VCO stages to accurately

lock the HF injection to the desired frequency.

The 40.5-MHz input to mixer U22 is delivered from the output of a second mixer Q23. This stage combines a 34.3-MHz input received through pin 19 of J1 with a second input that varies from 6.2 to 6.3 MHz. The second input is produced by a third mixer Q22 which combines a 5.7-MHz input received through pin 21 of J1 and a second input in the range 500.0-599.9 KHz.

50 MHZ VCO

The second input to Q22 is derived from 50-59 MHz VCO Q18, output from which is divided by a factor of 100 by U20 and U21. This VCO is accurately locked to the desired frequency by passing the VCO output through Programmed Divider U12 through U19 which is set by the processor to divide as necessary to produce a 10-KHz output. This output, together with the 10-KHz reference, is combined in phase discriminator U11. The DC output from U11 is filtered and applied to control the 50-MHz VCO frequency.

LOGIC CIRCUITRY

Microprocessor U4 processes data received either from the keyboard or CMOS RAM U2 and supplies data to the front-panel display and the synthesizer system. Additionally, U4 contains permanent storage of numerous frequency channels. Finally, U4 supplies data to the digital transmit power meter.

Data to the synthesizer divider and VCO select system is through U6 - U9, a serial data latch array. Latch U9 delivers six outputs that select the appropriate harmonic filter. The frequency range of the filters is as follows:

A - 1.6-2.8 MHz
B - 2.8-4.5
C - 4.5-7.0
D - 7.0-11.0
E - 11.0-19.0
F - 19.0-29.9

To select the correct HF VCO, Diodes CR13-17 combine the filter data to actuate any one of the three VCO's.

When squelch action is desired, pressing the "0" key causes the DC level at pin 31 of U4, normally high, to become low. This causes the collector of Q16 to become low and this level, outputted through pin 6 of J1, allows the squelch circuit on the Exciter board to operate.

DIGITAL POWER METER

The Digital Power meter system operates through a DC voltage from an antenna-output sampling circuit coupled to pin 9 of U10. The level of this voltage controls the frequency of a VCO contained in U10. Output from this VCO is delivered to pin 37 of processor

U4. The processor squares the frequency and delivers a peak power reading on the front-panel display when the "MTR" key is pressed.

SCAN

The processor enables any channels from 501 through 510 to be scanned by pressing the "7" key. Scanning can be interrupted by pressing the "8" key or, externally, by applying a ground to pin 4 of J1.

DISPLAY

Necessary high voltage for the front-panel display is generated by multivibrator Q11 and Q12. Output from this stage is voltage double rectified by CR4 and CR5 and regulated by Zener Diodes CR21-23.

FILTER BOARD

HARMONIC FILTERS

The Filter board contains six low-pass filters to reduce harmonic output from the transmitter to the required level. The appropriate filter is selected by outputs from the microprocessor arriving at the A through F terminals. U301 receives the six logic-level inputs and actuates Relays K301 through K312 as required. High-level RF power from the RF power amplifier arrives at the selected filter input through contacts on K313.

POWER DETECTOR

After passing through the filter, RF output is sampled by R304-R306 with C337 serving to flatten the frequency response of the network. Output from the network is rectified by CR305 and supplied to three adjustable outputs. R307 adjusts the output to the correct level required by the digital power meter system and is passed through Emitter Follower Q307. R308 supplies the DC output required for ALC action and is adjusted to limit the transmitter peak output to 150 watts. Finally, R309 provides a level that will hold inserted carrier output from the transmitter to about 10 watts when the Automatic Antenna Coupler is in the tune mode.

VSWR DETECTOR

Filtered output from the transmitter is also sampled by pick-up coil L317 and C336. This circuit, together with CR304, forms a VSWR detector that generates a positive-going DC output when the load connected to the antenna terminal is other than 50 ohms resistive.

SWR AMPLIFIER

Q303 and Q304 form a DC amplifier that controls the gain of the

Transmit IF amplifier on the Exciter board. Q303 receives an input from either the VSWR detector or the TUNE adjustment depending on the condition of U303D and U303C. Only one section conducts at any given time. Selection between the two is controlled by the voltage applied through R303 from the PTT line. When the CPLR KEY terminal is grounded (when the coupler is tuning) the voltage through R303 is low causing U303A, B & D to be open-circuited. Since U303B controls the conduction of U303C, this stage conducts and the DC level from the TUNE pot passes to the input of Q303. When the transmitter is keyed from the microphone button, the voltage at R303 remains high and U303D conducts thus passing the level from the VSWR detector to Q303.

COUPLER KEYING

Coupler keying is controlled by a Lock signal arriving from the synthesizer board. When the synthesizer is out of lock, the Lock line switches from high to low. Through Q305 and Q306, the CPLR START terminal also switches low. When lock has been achieved, the CPLR START terminal reverts to high and this change initiates a Coupler tune cycle.

OPTIONAL EQUIPMENT

EMERGENCY TONE GENERATOR

By adding the EMER module to the Model 230, the two-tone emergency transmission at 2182 KHz can be made. Pressing the "3" and "4" keys simultaneously causes the processor to select 2182.0 KHz and deliver a 1-Hz square wave output at pin 35 for a period of 35 seconds. This output is passed through pin 2 of J1 to the PULSE input of the Emergency Tone Generator.

Referring to the Tone Generator schematic diagram, the pulse is inverted by Q703 and applied through Inverters U701D & C and CR701 to one-shot Multivibrator U701 A & B. As long as pulses are being delivered, the one-shot remains fired. Output from the one-shot, through Q701 and Q702 keys the transmitter on.

Square wave output from U701D is also applied through R717 to Switch U702. This switch controls the frequency of R/C Oscillator U703B by effectively shorting R710 thus raising the oscillator frequency from 1300 Hz to 2200 Hz. Output from U703B, alternating in frequency at a 1-Hz rate, is equalized in amplitude by R706 and C705 and applied to follower U703A. Output from this stage, adjusted in amplitude by R703, is delivered to the microphone input of the transmitter.

When the input pulses cease, the one-shot times out and the tranamitter turns off.

CW MODULE

Delayed break-in CW operation with the Model 230 is possible

using the optional CW Module. When factory installed, a special narrow-bandwidth 10.68-MHz filter is normally supplied for optimum receiver performance. This filter is automatically switched in when CW is selected on the front-panel MODE switch.

Referring to the CW Module schematic diagram, the KEY terminal connects to the external Morse key. When the KEY terminal grounds, Clamp Q604 is disabled and an audio tone from Audio Oscillator Q601 is passed to the TONE output terminal which connects to the Microphone line of the Radiotelephone. In addition the tone is suitably level controlled by R613 and coupled through the SIDETONE terminal to the input of the speaker amplifier. Q602, Q603, CR601 and CR602 operate as an automatic level control for Oscillator Q601 to prevent tone distortion and varying output.

Grounding the KEY terminal also removes the positive base bias on Q605 thus placing Q606 in conduction. This action keys the transmitter on. R615 and C608 act to hold the PTT circuit on for a brief period after the key is released to prevent excessive relay clatter.

SECTION V

MAINTENANCE AND REPAIR

GENERAL

This section contains information needed to repair and maintain Hull Model 230 SSB Radiotelephone.

Complete alignment of the unit as a maintenance procedure is not recommended. Malfunction will almost always be caused by the failure of a component since the various adjustments are designed to stay in alignment permanently under all normal conditions.

EQUIPMENT NEEDED

The alignment procedures given below require all or part of the following test instruments:

Signal Generator, HP-8640 or equal
Frequency counter, 8 digits, 100 MHz response
Dummy Load, 50 Ohms resistive, 200 watts min.
Oscilloscope, 100 MHz response
High-impedance VTVM
Two-tone Audio Generator

FREQUENCY RESET

Turn the set on and allow to warm up for at least 5 minutes. Set the front-panel MODE switch to USB.

Connect a counter to the test point labelled "34". Adjust piston trimmer C181 near the right front corner of the board for a counter reading of exactly 34,320.0 KHz.

ADJUSTMENTS

NOTE: The following adjustments have been made as a part of factory test and alignment. They will not ordinarily need readjustment during the life of the product. Make certain that the unit is otherwise normal before changing the various adjustments.

SQUELCH

Remove the cabinet and connect the unit to a power source and live antenna. Select a typical channel in the 6 - 8 MHz range and press the front-panel "0" key. Note that a small segment at the upper left corner of the display lights. Also, with no signal being received, noise should be squelched off. If occasional noise bursts open the squelch, turn the SQUELCH control slightly clockwise. Pause for a few seconds before

making further adjustments since the circuit contains a long time delay. Do not turn further clockwise than necessary since this could mask weak signals.

If weak signals are being missed when the squelch is activated, turn the SQUELCH control counter clockwise slightly, again pausing before making a further adjustment.

BAL (Exciter Board)

Connect the unit to a 50-ohm resistive dummy load. Select a channel near 8 MHz and whistle into the microphone to make certain that normal power output is delivered. Now connect an oscilloscope to the antenna connector and, with a clip lead, ground the MIC test point on the Exciter board. Press the microphone button. If the oscilloscope pattern is more than 2 volts peak-to-peak, adjust the BAL pot for minimum scope deflection.

CARRIER INSERT (Exciter Board)

Connect the unit to a 50-ohm resistive dummy load. Select 2182.0 KHz simplex. Connect the scope to the antenna connector and select AME on the front-panel MODE selector switch. Press the microphone button and set the CARRIER INSERT pot for a scope deflection of 122 volts peak-to-peak.

CARRIER VCO (Exciter Board)

Set the MODE switch to USB. Connect a VTVM to the test point labelled "10.6". Adjust the slug of T105 for a meter reading of 3.5 volts DC.

TUNE (Filter Board)

Connect the unit to a 50-ohm resistive dummy load. Select a 4-MHz simplex channel. Connect the scope to the antenna connector and, with a clip lead, ground the "KEY" coupler terminal on the rear panel. Adjust the TUNE pot for a scope deflection of 22 volts peak-to-peak.

ALC (Filter Board)

Connect the unit to a 50-ohm resistive dummy load. Select a 4-MHz simplex channel. Connect the scope to the antenna connector and press the microphone button. Speak a prolonged "AHHHH" into the microphone and adjust the ALC pot until voice peaks do not exceed 245 volts peak-to-peak.

SWR (Filter Board)

Connect the VTVM to the SWR test point. Select a 12-MHz channel and set the MODE switch to AME. Press the microphone button and adjust the SWR ceramic trimmer capacitor for minimum VTVM voltage reading.

MTR (Filter Board)

Connect the unit to a 50-ohm resistive dummy load. Select a 12-MHz channel and connect the scope to the MTR terminal on the Filter board. Adjust the scope to indicate 1 volt DC per cm. Whistle into the microphone and adjust the MTR pot for a scope reading of exactly 7 volts DC.

MTR (Synthesizer Board)

After completing the MTR (Filter board) adjustment, press the microphone button and press the MTR key on the keyboard. Adjust the MTR (Synthesizer board) pot until the display reads 150 while whistling continuously into the microphone.

RECEIVER ALIGNMENT

Select 2182.0 KHz simplex. Connect a signal generator to the antenna connector and set the MODE selector to USB. Adjust the generator until an audible signal is heard and reduce generator output as much as possible. Now adjust the slugs of T102, L106, T103 and L108 in sequence for best audio output. Now, connect a DC VTVM to the AGC test point on the Exciter board. With a moderate signal from the generator, adjust L113 for minimum positive (+) voltage. If the VTVM reads negative, reduce output from the generator as required.

TRANSMITTER ALIGNMENT

With the 50-ohm resistive dummy load and the scope connected to the antenna connector, select 2182.0 KHz simplex and connect a two-tone generator to the MIC test point on the Exciter board. Adjust the two-tone level to exactly 1.0 volt peak-to-peak. Now press the microphone button and adjust T104 until power output is 245 volts p-p on the scope. Note that T104 serves as an overall transmitter gain control and should not be set for highest peak output.

EMERGENCY TONE GENERATOR

LIVE OPERATIONAL TEST

To test the Emergency Tone Generator for correct operation into a live antenna without interfering with the Emergency service, press simultaneously the "5" and "6" keys for one second. The unit will select 2142.0 KHz and transmit 1300 and 2200-Hz tones for 35 seconds.

TONE ADJUSTMENT

Without a channel selected, ground the TEST terminal on the EMER module. Connect the counter to pin 1 of the 1458 OP amp. Adjust the 2200 pot for a counter reading of exactly 2200 Hz. Now ground the 1300 test point with another clip lead and adjust the

1300 pot for a counter reading of exactly 1300 Hz.

LITHIUM BATTERY REPLACEMENT

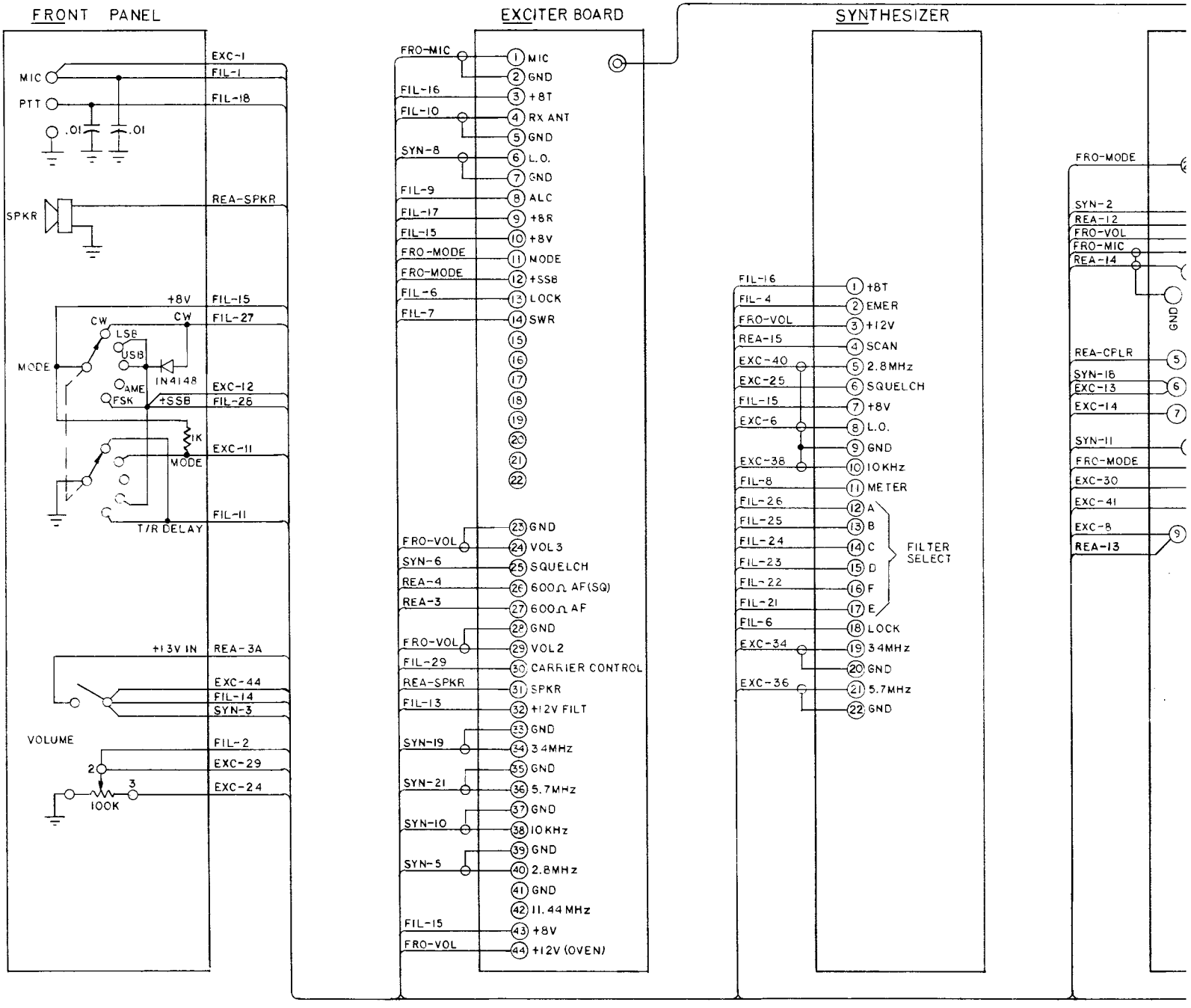
The Lithium keep-alive battery located on the Synthesizer board has a useful life of five years or more. To prevent loss of stored data, a new battery should be installed on or before five years from date of purchase. A small tag, attached to the microphone cord, is intended to be mailed to the factory. Upon receipt, a new battery will be sent to the address specified by the customer free of charge.

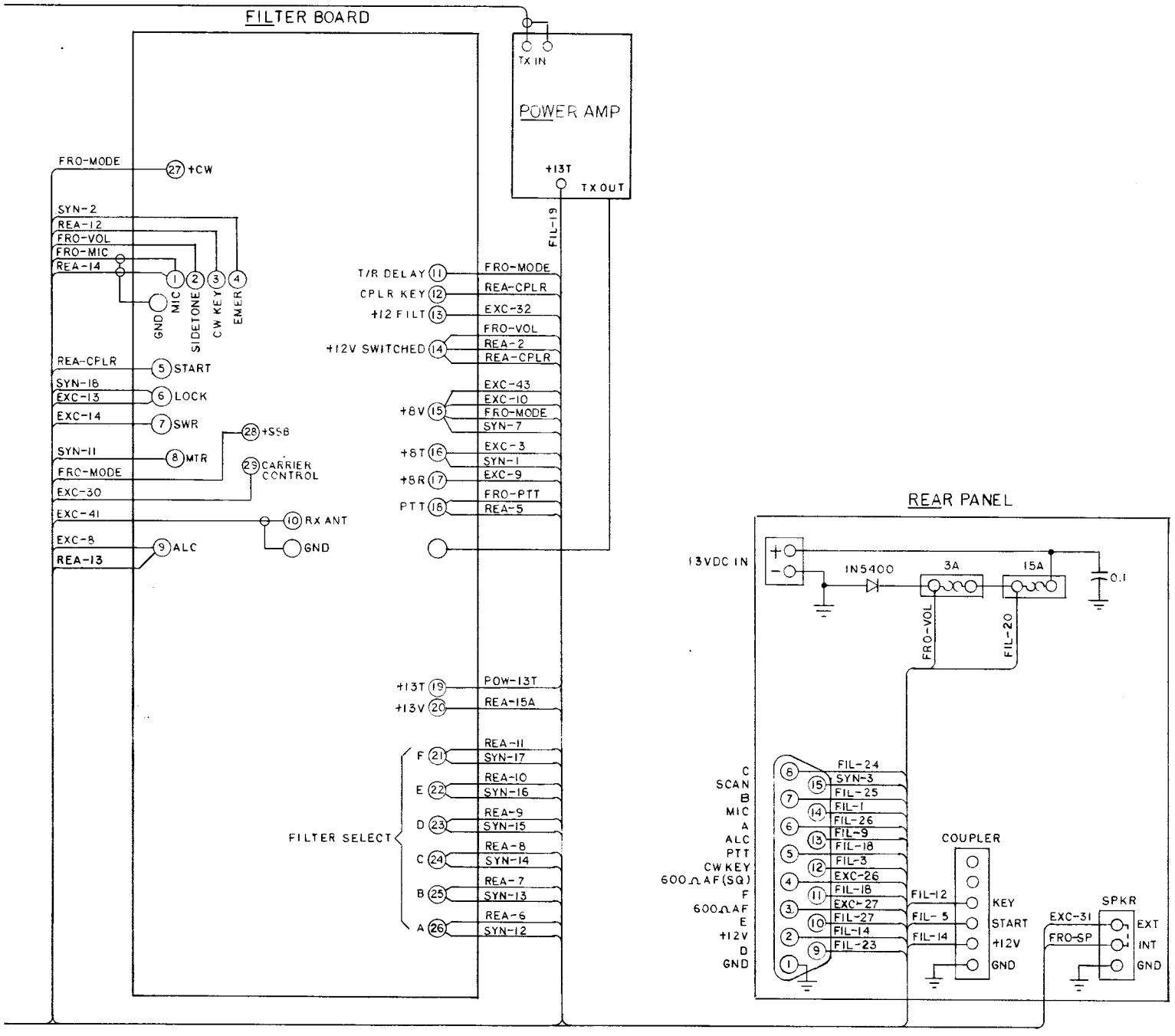
To replace the battery, remove the cabinet and locate the battery and holder on the Synthesizer board. It is very important that the replacement be made with the unit turned ON. (If the battery is removed with the set turned off, all stored data in the RAM will be lost). With a blade, pry up and remove the battery from the holder. Before installing the new battery, inspect the holder for signs of corrosion and dirt that could prevent a solid electrical connection to the battery. Finally, slip the new battery into the holder with the side marked "+" upward.

SCAN CONTROL

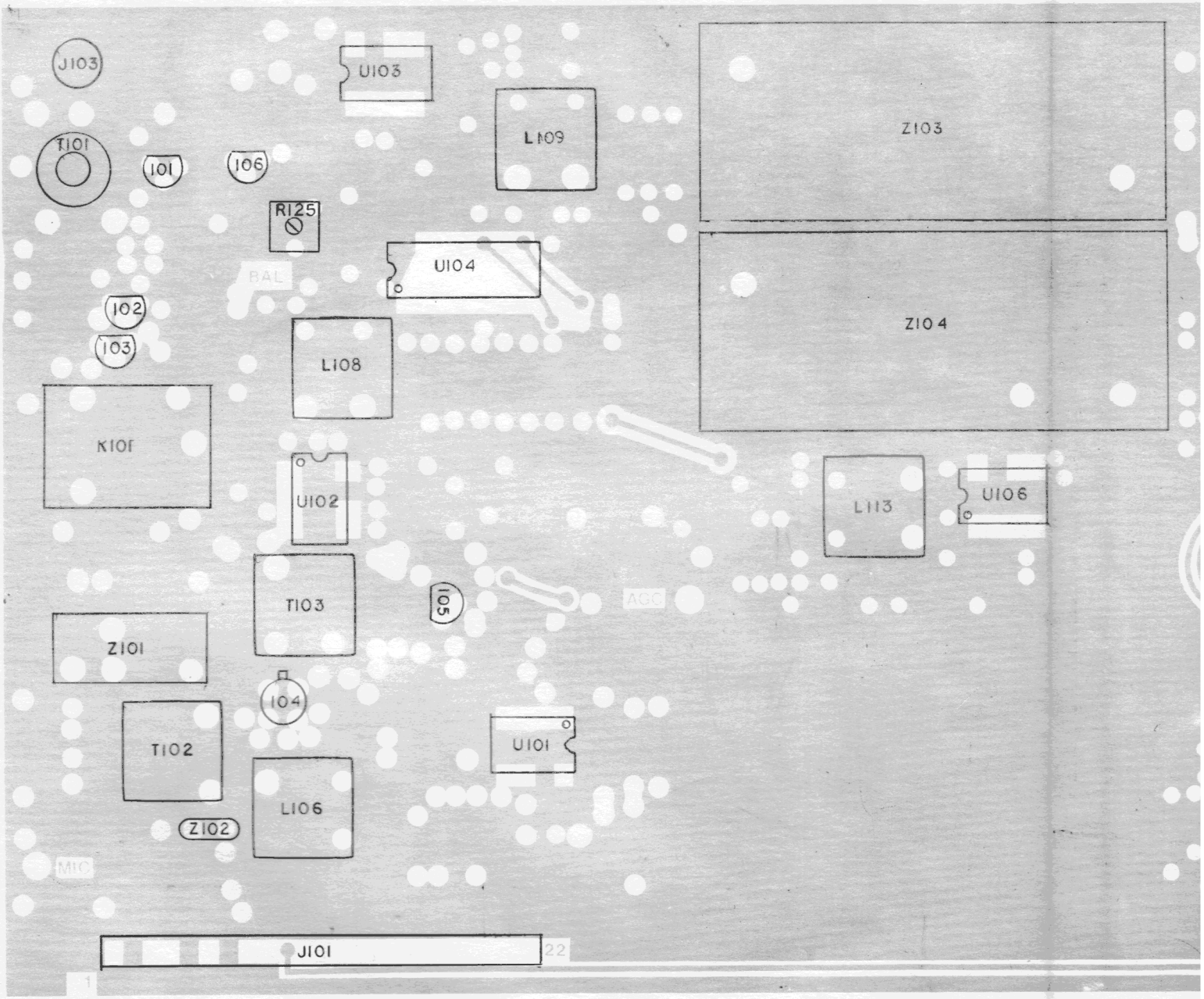
As delivered from the factory, the Model 230 is set to start and stop the Scan feature either by pressing the "7" and "8" keys on the keyboard. It is possible to stop the Scan using the Squelch system of the set. Referring to the Synthesizer Board schematic diagram, note that a type 2N4124 transistor is installed on the board with its collector connected to the line leading to Pin 4 of J1. The emitter of the transistor is grounded. To enable the Squelch-scan stop feature, install a 100K, 1/4 watt resistor from the base of the transistor to the line leading to Pin 6 of J1. Holes are provided on the board for this purpose.

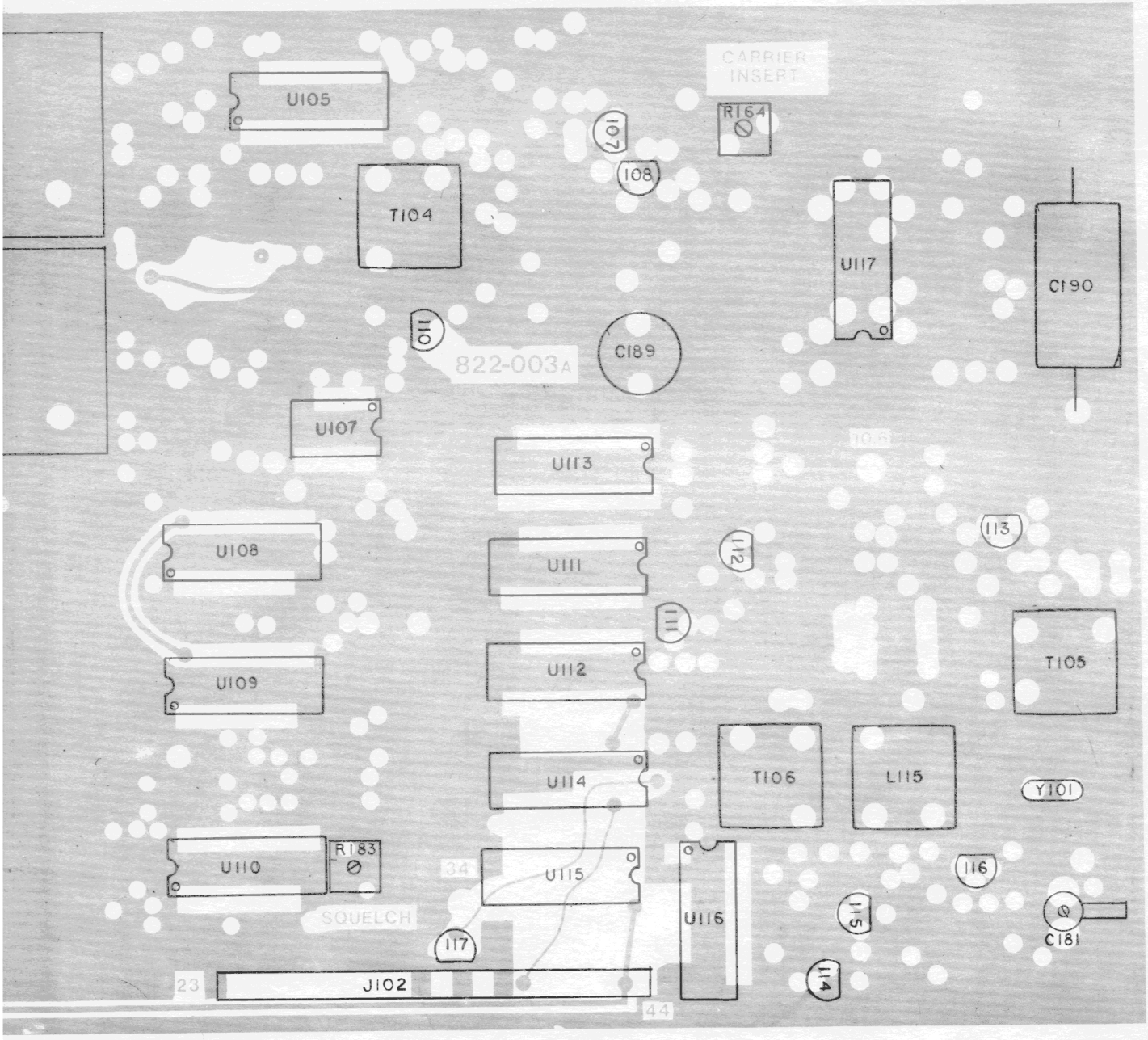
If the Squelch-stop scan is enabled, instruct the user to activate the Squelch (press the "0" key) and then start the scan (press the "7" key). The scan will stop when the Squelch is broken and will re-start when the Squelch again functions at the end of the transmission.


FRONT PANEL
EXCITER BOARD
SYNTHESIZER
MIC
PTT
.01
.01
EXC-1
FIL-1
FIL-18
SPKR
REA-SPKR
+8V
FIL-15
CW
CW
FIL-27
LSB
USB
MODE
AME
FSK
IN4148
EXC-12
+SSB
FIL-26
1K
EXC-11
MODE
FIL-11
T/R DELAY
+13V IN
REA-3A
EXC-44
FIL-14
SYN-3
VOLUME
FIL-2
2
EXC-29
3
EXC-24
100K
FRO-MIC
1 MIC
2 GND
FIL-16
3 +8T
FIL-10
4 RX ANT
5 GND
SYN-8
6 L.O.
7 GND
FIL-9
8 ALC
FIL-17
9 +8R
FIL-15
10 +8V
FRO-MODE
11 MODE
FRO-MODE
12 +SSB
FIL-6
13 LOCK
FIL-7
14 SWR
15
16
17
18
19
20
21
22
23 GND
FRO-VOL
24 VOL 3
SYN-6
25 SQUELCH
REA-4
26 600Ω AF(SQ)
REA-3
27 600Ω AF
28 GND
FRO-VOL
29 VOL 2
FIL-29
30 CARRIER CONTROL
REA-SPKR
31 SPKR
FIL-13
32 +12V FILT
33 GND
SYN-19
34 34MHz
35 GND
SYN-21
36 5.7MHz
37 GND
SYN-10
38 10KHz
39 GND
SYN-5
40 2.8MHz
41 GND
42 11.44 MHz
FIL-15
43 +8V
FRO-VOL
44 +12V (OVEN)
FIL-16
FIL-4
FRO-VOL
REA-15
EXC-40
EXC-25
FIL-15
EXC-6
EXC-38
FIL-8
FIL-26
FIL-25
FIL-24
FIL-23
FIL-22
FIL-21
FIL-6
EXC-34
EXC-36
1 +8T
2 EMER
3 +12V
4 SCAN
5 2.8MHz
6 SQUELCH
7 +8V
8 L.O.
9 GND
10 10KHz
11 METER
12 A
13 B
14 C
15 D
16 F
17 E
FILTER SELECT
18 LOCK
19 34MHz
20 GND
21 5.7MHz
22 GND
FRO-MODE
SYN-2
REA-12
FRO-VOL
FRO-MIC
REA-14
GND
REA-CFLR
5
SYN-16
EXC-13
6
EXC-14
7
SYN-11
FRO-MODE
EXC-30
EXC-41
EXC-8
9
REA-13

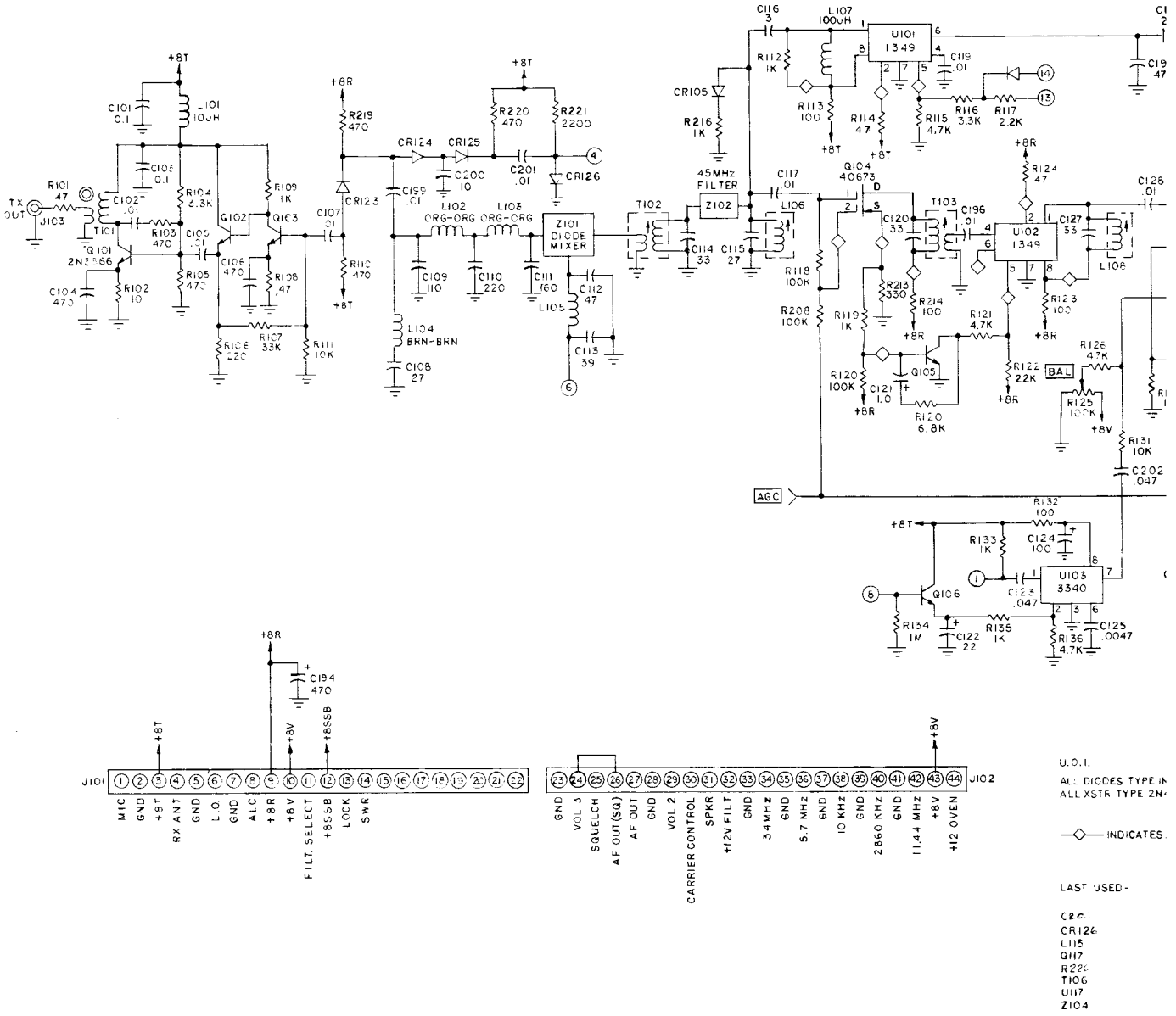


MODEL 230
INTERCONNECT DIAGRAM


J103
U103
L109
Z103
T101
101
106
R125
U104
BAL
Z104
102
103
L108
K101
U102
L113
U106
T103
105
AGC
Z101
104
T102
U101
L106
Z102
MIC
J101
22
1



PARTS LOCATION
MODEL 230
EXCITER BOARD



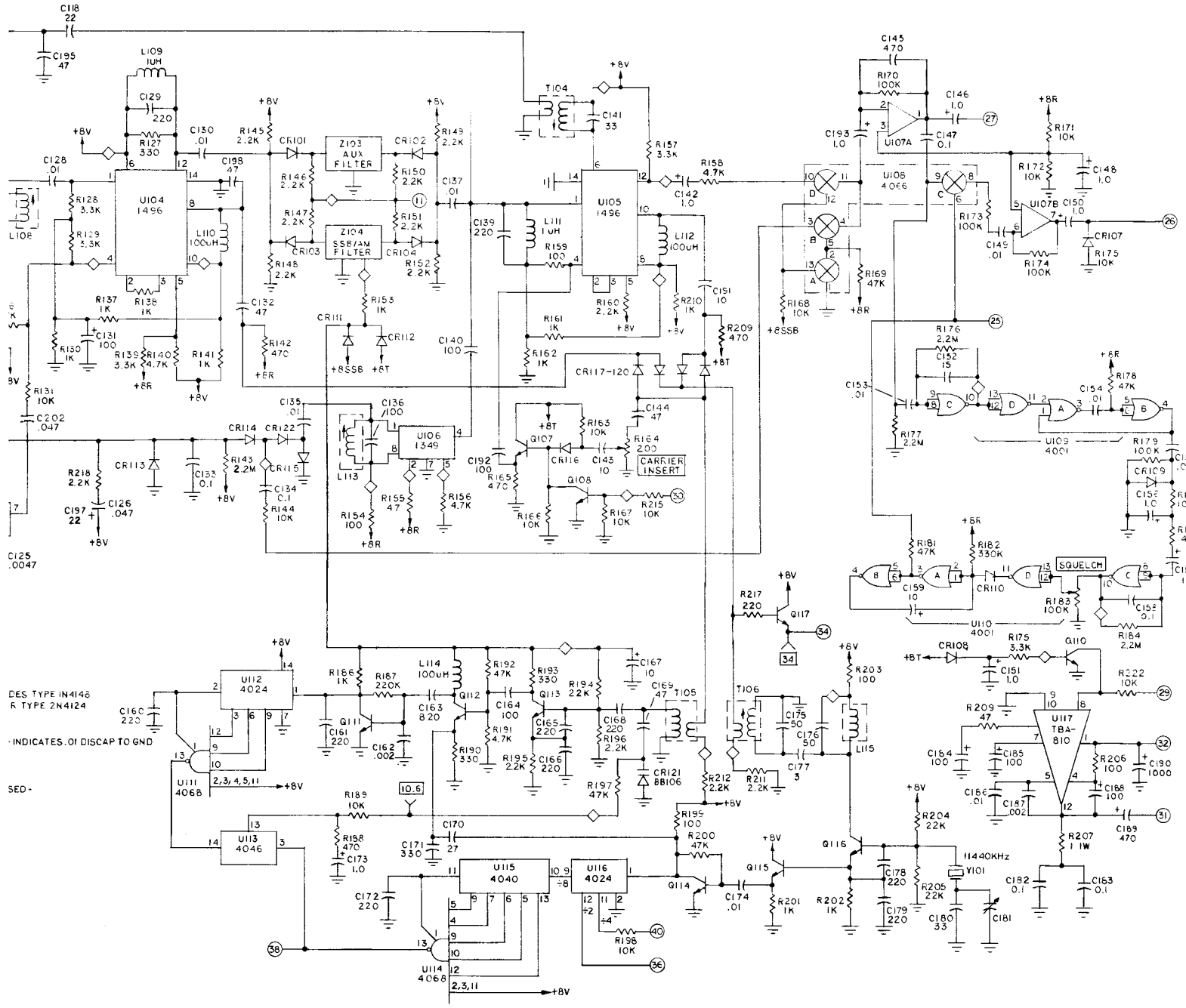
U.O.I.

ALL DIODES TYPE IN
ALL XSTR TYPE 2N

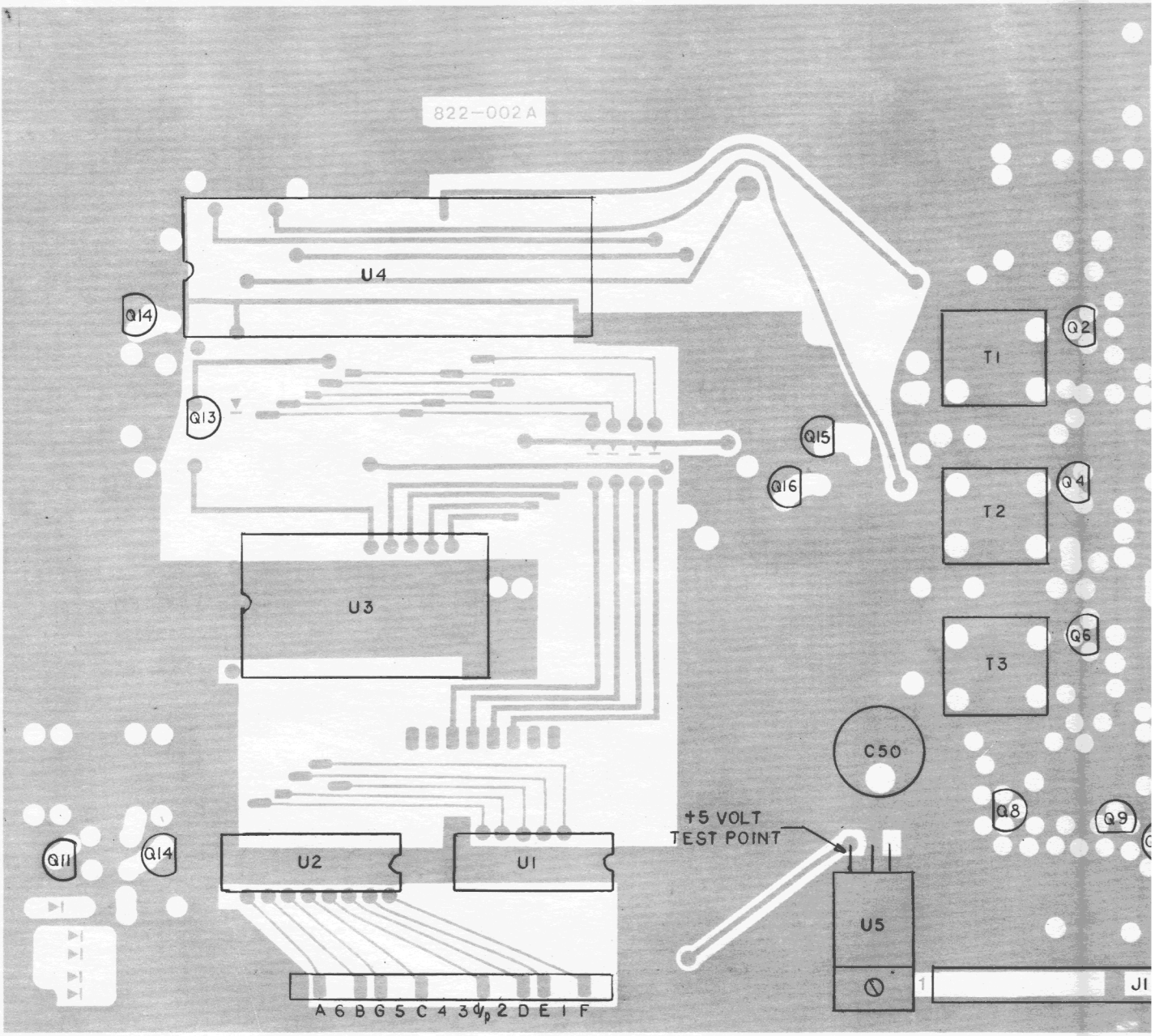
—◇— INDICATES

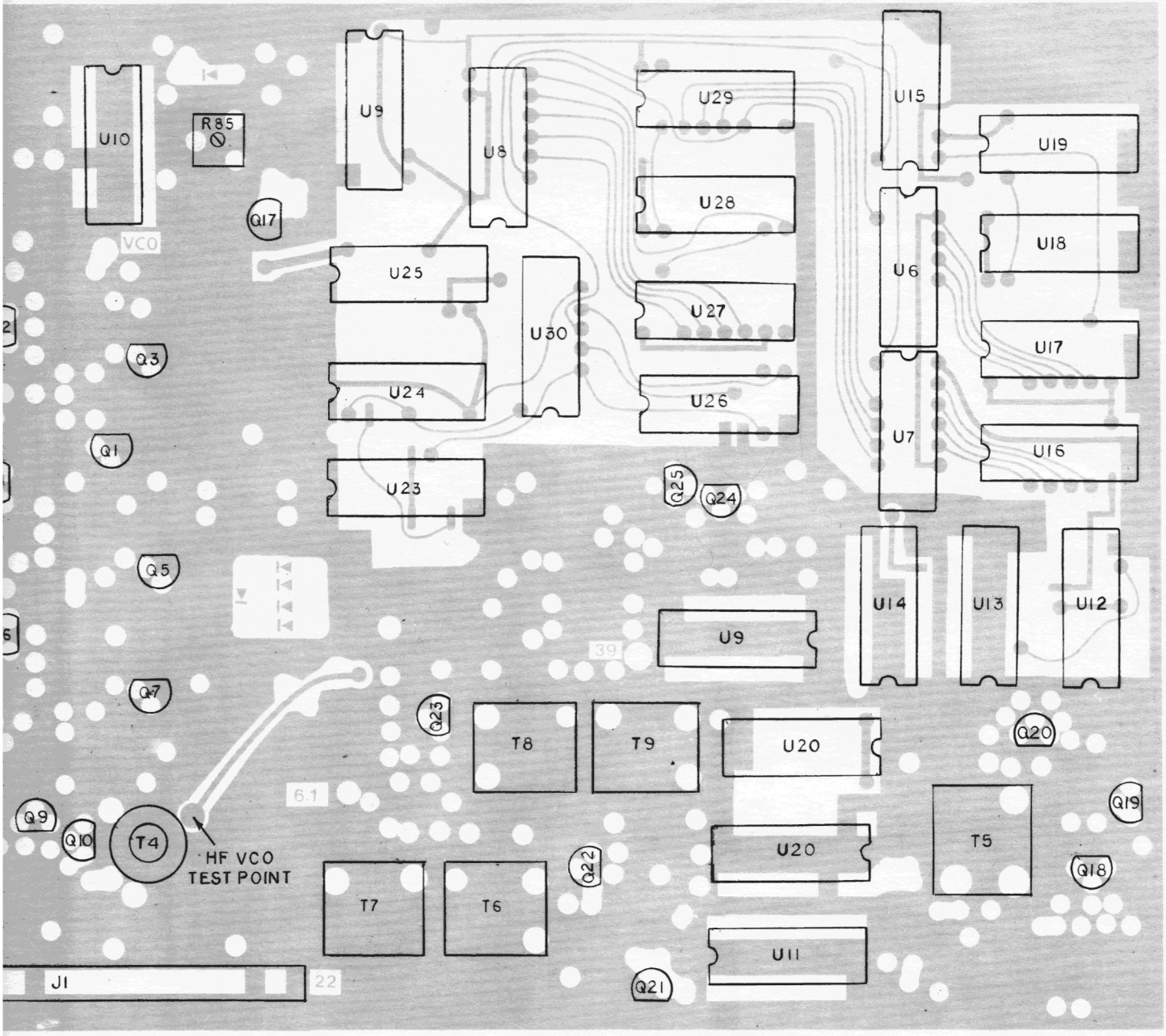
LAST USED-

C126
CR126
L115
Q117
R223
T106
U117
Z104

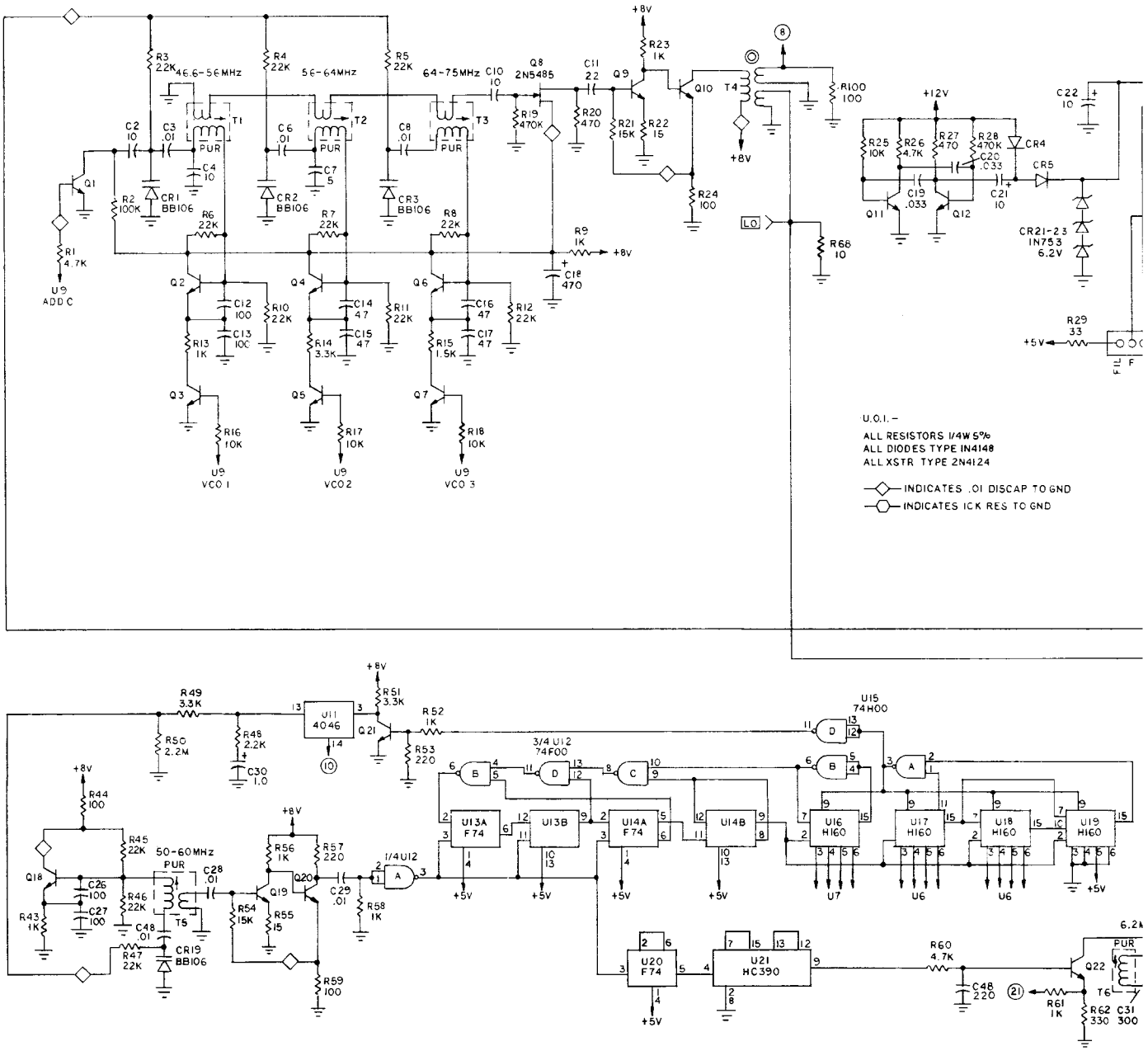


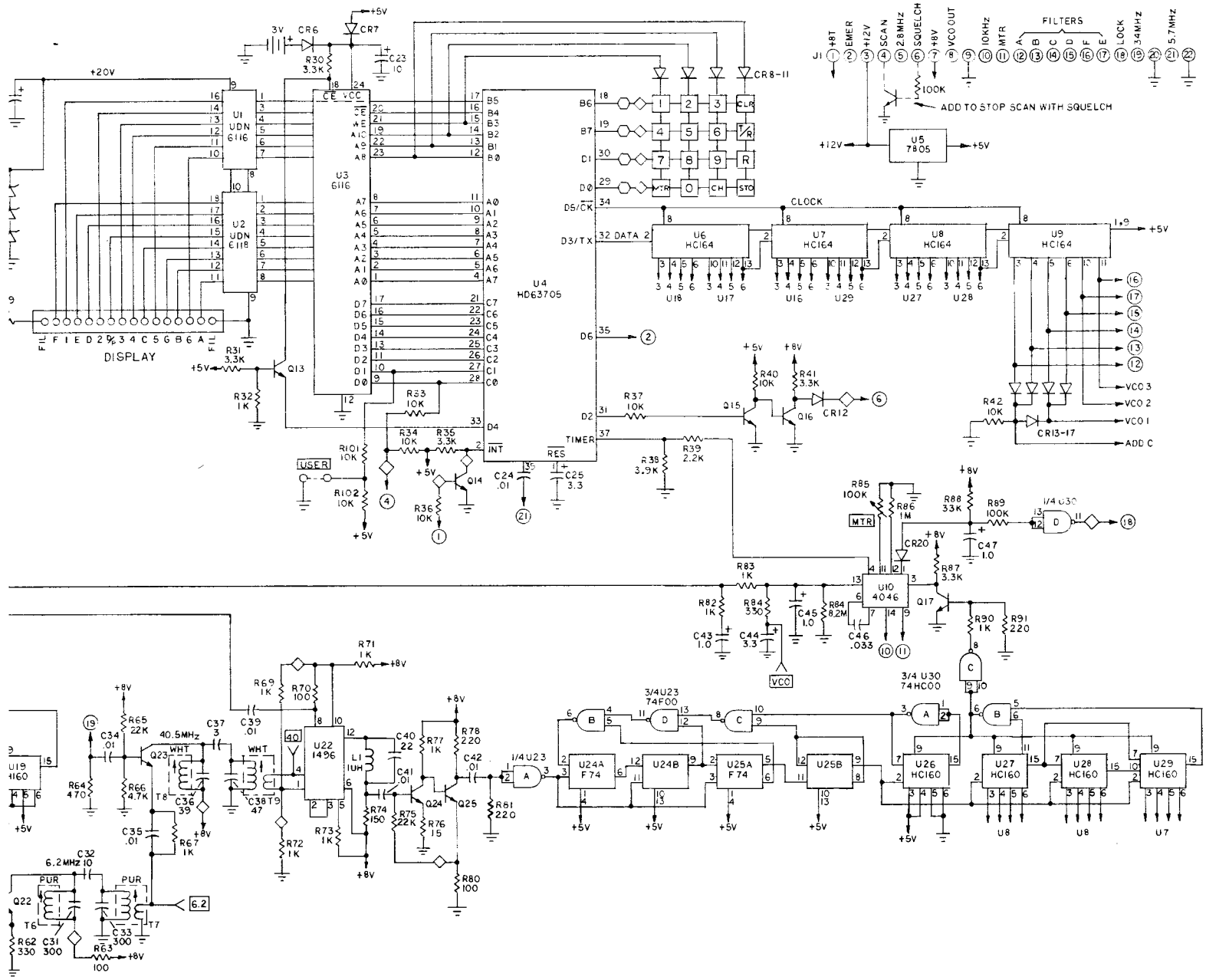
MODEL 230
EXCITER BOARD


822-002 A
U4
Q14
Q13
T1
Q2
Q15
Q16
T2
Q4
U3
T3
Q6
C50
+5 VOLT
TEST POINT
Q8
Q9
Q11
Q14
U2
U1
U5
J1
A 6 B G 5 C 4 3 ϕ_p 2 D E I F

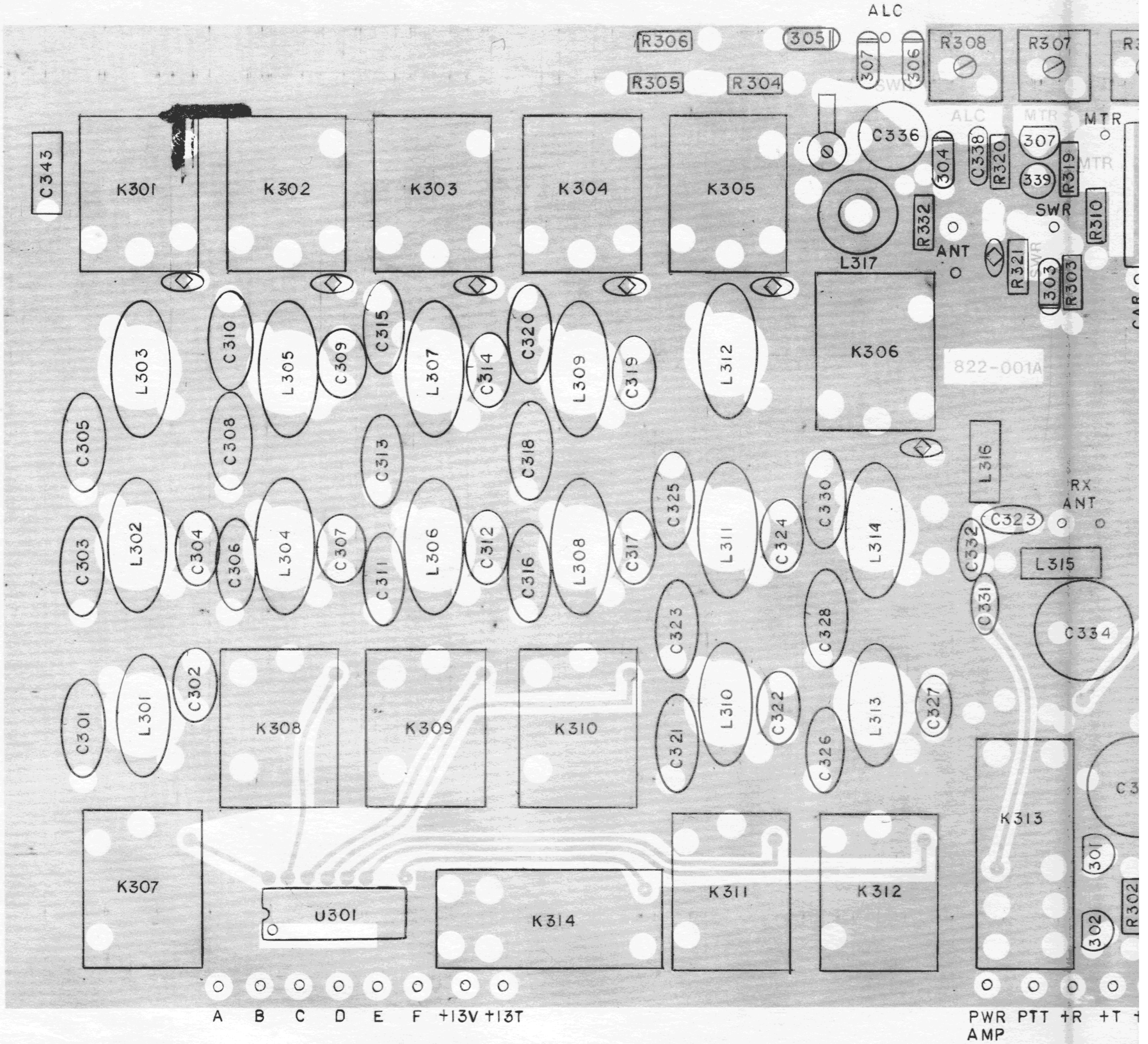


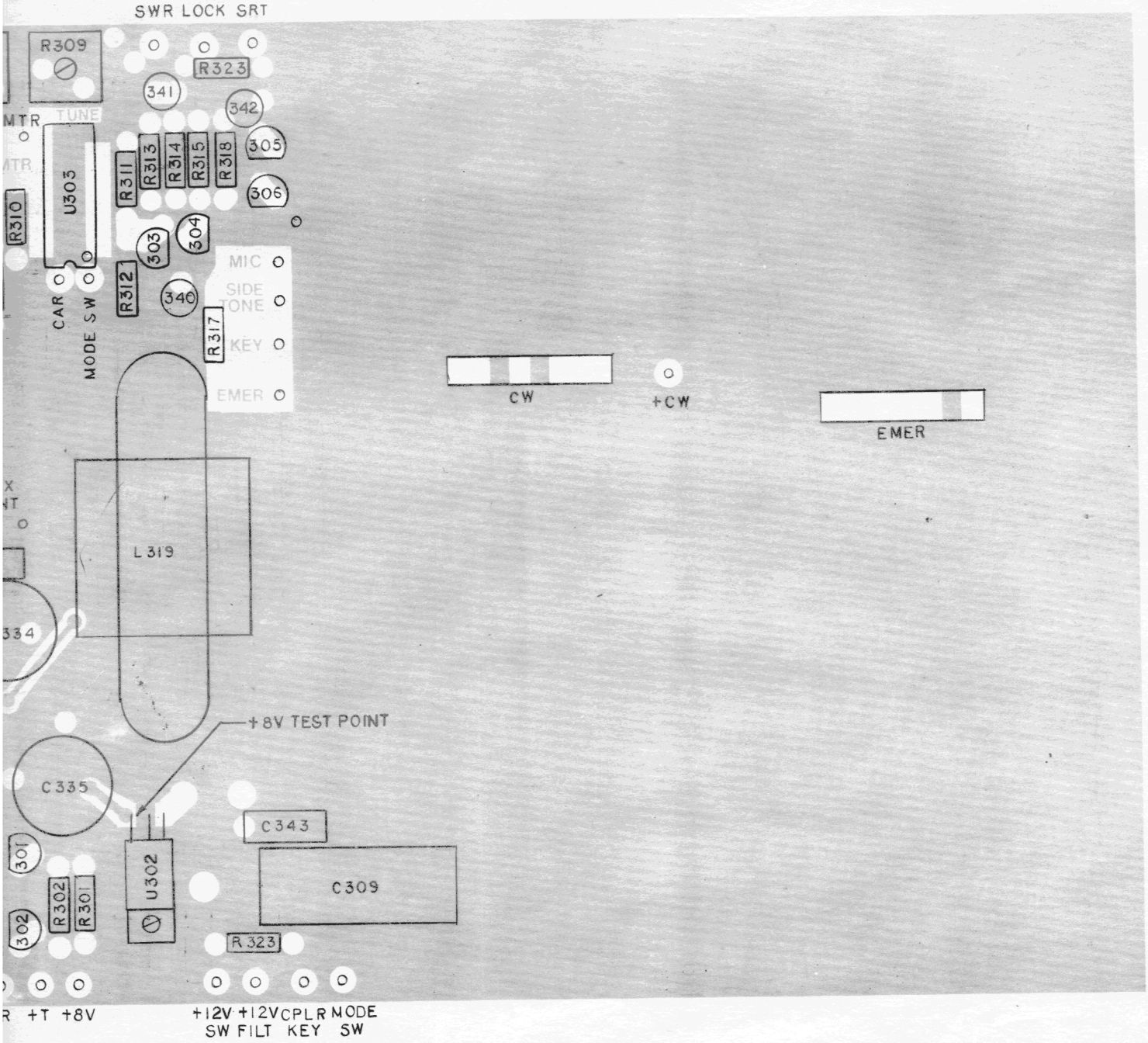
PARTS LOCATION
MODEL 230
SYNTHESIZER BOARD


+8V
R3 22K
R4 22K
R5 22K
46.6-56MHz
56-64MHz
64-75MHz
C10 10
Q8 2N5485
C11 22
Q9
R23 1K
Q10
T4
8
.R100 100
+8V
+12V
C22 10
R25 10K
R26 4.7K
R27 470
R28 470K
C20 .033
CR4
CR5
C19 .033
C21 10
Q11
Q12
CR21-23 IN753 6.2V
R29 33
+5V
FIL F
T1
T2
T3
C2 10
C3 .01
C6 .01
C8 .01
PUR
C4 10
C7 5
Q1
R2 100K
CR1 BB106
CR2 BB106
CR3 BB106
R19 470K
R20 470
R21 15K
R22 15
R24 100
LO
R68 10
R1 4.7K
U9 ADD C
R6 22K
R7 22K
R8 22K
R9 1K
+8V
C18 470
Q2
Q4
Q6
C12 100
C13 100
C14 47
C15 47
C16 47
C17 47
R10 22K
R11 22K
R12 22K
R13 1K
R14 3.3K
R15 1.5K
Q3
Q5
Q7
R16 10K
R17 10K
R18 10K
U9 VCO 1
U9 VCO 2
U9 VCO 3
U.O.I. -
ALL RESISTORS 1/4W 5%
ALL DIODES TYPE IN4148
ALL XSTR TYPE 2N4124
INDICATES .01 DISCAP TO GND
INDICATES ICK RES TO GND
R49 3.3K
R50 2.2M
R48 2.2K
C30 1.0
U11 4046
R51 3.3K
Q21
R52 1K
R53 220
10
U15 74H00
3/4 U12 74F00
U13A F74
U13B
U14A F74
U14B
U16 H160
U17 H160
U18 H160
U19 H160
U7
U6
U6
+5V
R44 100
R45 22K
50-60MHz
PUR
C28 .01
Q18
C26 100
C27 100
R43 1K
R46 22K
C48 .01
R47 22K
T5
CR19 BB106
R56 1K
R57 220
Q19
Q20
C29 .01
R54 15K
R55 15
R58 1K
R59 100
1/4 U12
U20 F74
U21 HC390
R60 4.7K
C48 220
21
R61 1K
Q22
T6
R62 330
C31 300
6.2k

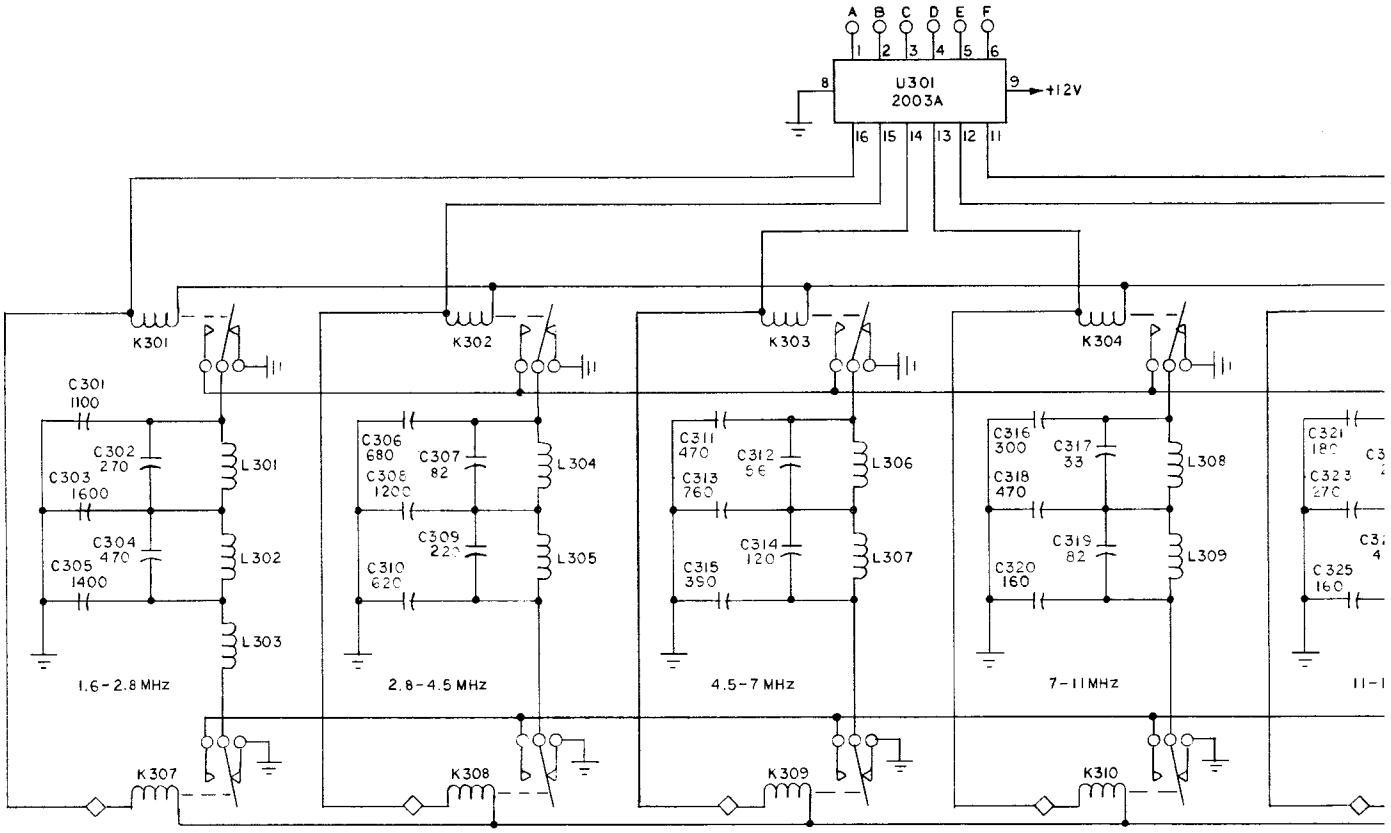


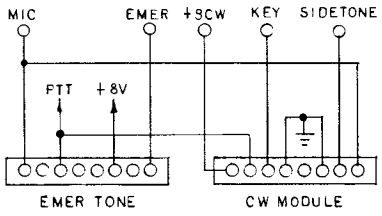
MODEL 230
SYNTHESIZER BOARD


ALC
R306
305
R305
R304
307
306
R308
R307
MTR
C343
K301
K302
K303
K304
K305
C336
304
C338
R320
307
339
R319
R332
L317
ANT
SWR
R321
303
R303
R310
K306
822-001A
L303
C310
L305
C309
C315
L307
C314
C320
L309
C319
L312
C305
C308
C313
C318
L316
RX ANT
C303
L302
C304
C306
L304
C307
C311
L306
C312
C316
L308
C317
C325
L311
C324
C330
L314
C323
C332
L315
C331
C334
C323
C328
C301
L301
C302
K308
K309
K310
C321
L310
C322
C326
L313
C327
K313
301
K307
U301
K314
K311
K312
R302
302
A
B
C
D
E
F
+13V
+13T
PWR AMP
PTT
+R
+T

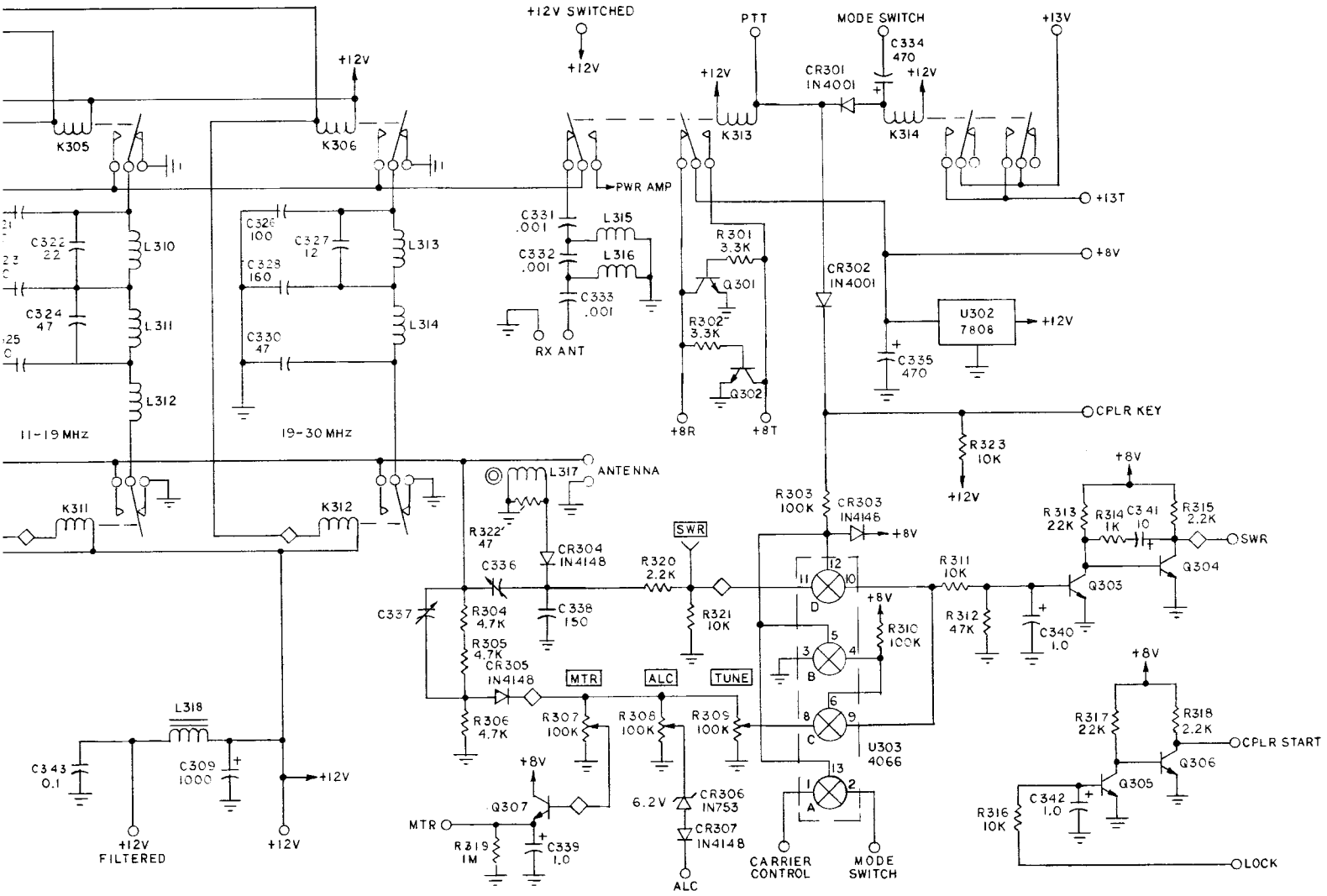


PARTS LOCATION
MODEL 230
FILTER BOARD





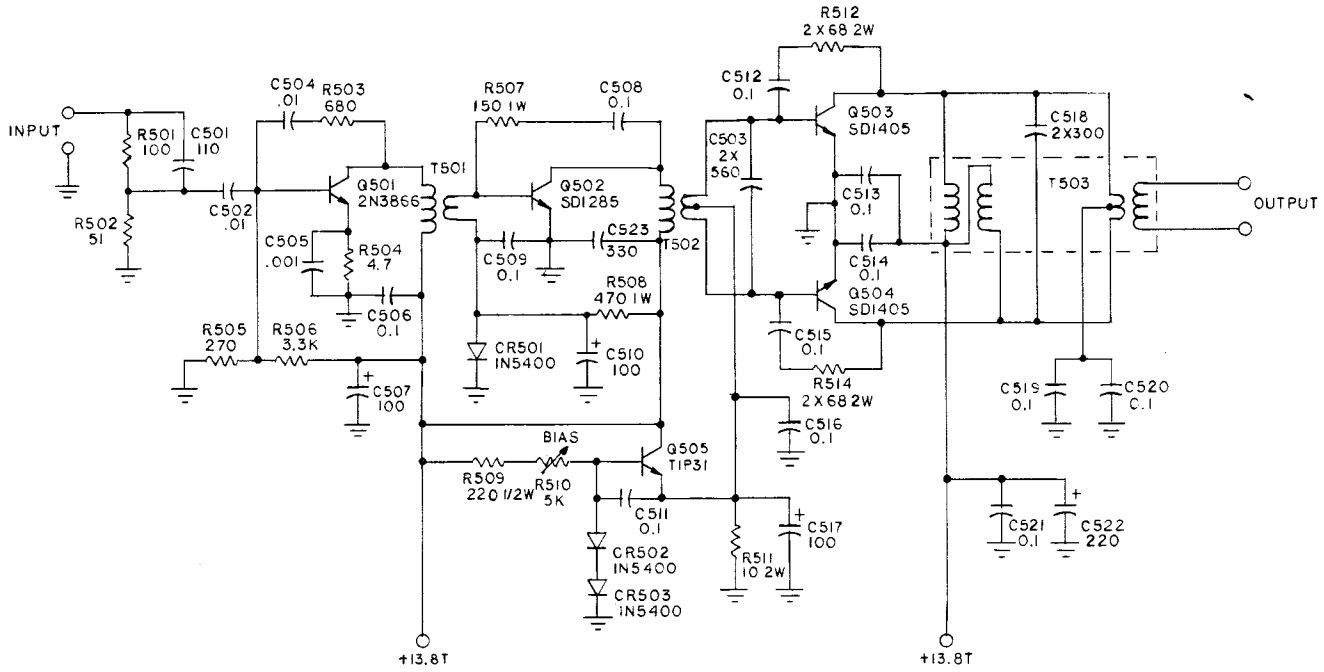
INDICATES .01 DISC CAP. TO GND
ALL XSTR TYPE 2N4124



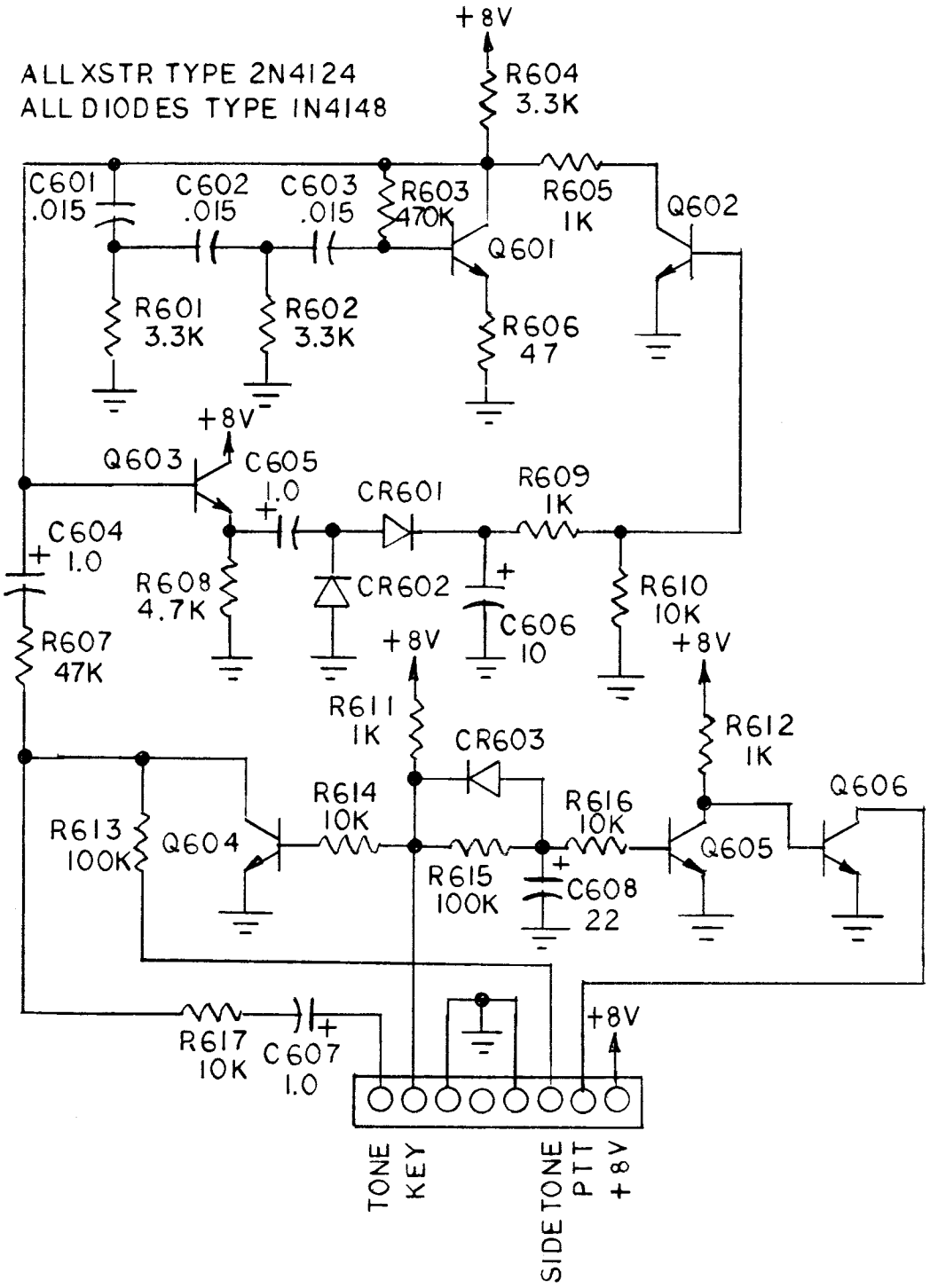
LAST USED

C343
CR307
L318
K314
Q307
R323
U303

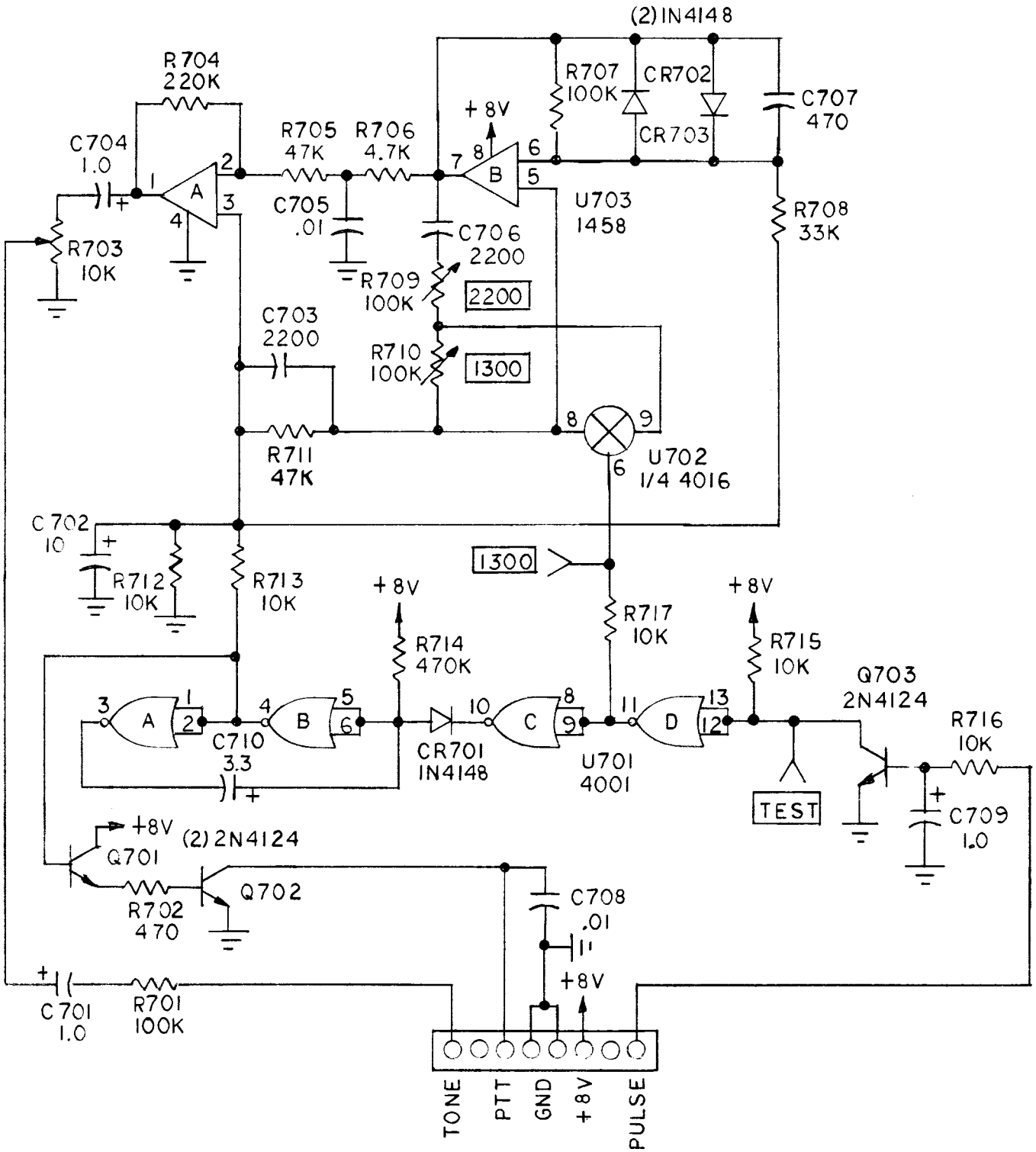
MODEL 230
FILTER BOARD



MODEL 230
TRANSMIT POWER AMPLIFIER



MODEL 230
CW MODULE



MODEL 230
EMERGENCY TONE GEN

WARRANTY

THIS PRODUCT WAS SHIPPED WITH OUR LIMITED WARRANTY CERTIFICATE AND LIMITED WARRANTY REGISTRATION CARD. BE SURE THAT THE REGISTRATION CARD IS COMPLETED AND MAILED.

HULL ELECTRONICS COMPANY RESERVES THE RIGHT TO MAKE PERIODIC PRODUCT IMPROVEMENTS OR MODIFICATIONS TO ITS PRODUCTS WITHOUT BEING OBLIGATED TO RETROFIT OR MODIFY ANY PRODUCT WHICH HAS ALREADY BEEN SHIPPED.

Hull Electronics Company
San Diego, California